This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

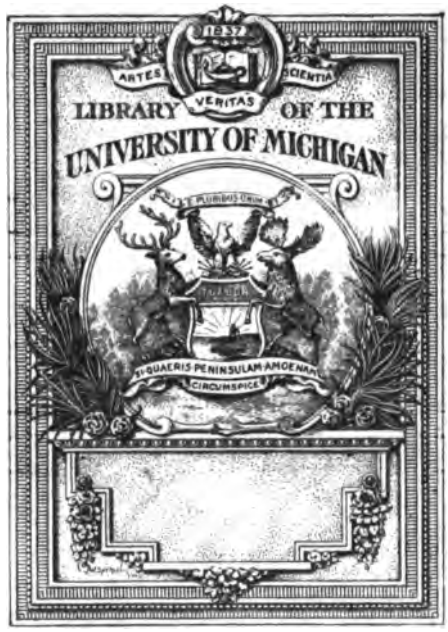
About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

147
.A2
1907-1908

B 1,065,754

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY


ARTES
VERITAS
SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
SI QUAERIS PENINSULAM AMOENAM
CIRCUMSPICE

THE GIFT OF
Die survey.

QE.
147
.A2

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

GEOLOGICAL BOARD

GOVERNOR R. B. GLENN, *ex officio Chairman*	Raleigh.
HENRY E. FRIES	Winston-Salem.
FRANK R. HEWITT	Asheville.
HUGH MACRAE	Wilmington.
FRANK WOOD	Edenton.

JOSEPH HYDE PRATT, State Geologist	Chapel Hill.

LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., January 1, 1908.

To His Excellency, GOVERNOR R. B. GLENN:

I herewith have the honor to submit for your consideration my Biennial Report relating to the operations of the North Carolina Geological and Economic Survey for the fiscal years 1907 and 1908. It has only been possible to give in this report a brief outline of the work of the Survey and for more detailed information, reference should be made to the reports that have been published on the various subjects investigated.

Suggestions have been made regarding legislation relating to the perpetuation of forests and the prevention of forest fires; good roads and the appointment of a highway commission; drainage of swamp lands; and the cultivation of the oyster. I beg to call your particular attention to these, as I deem them of the most vital importance to the industrial advancement of North Carolina.

At the end of the report I have given a statement regarding the expenditures of the Survey, showing approximately the cost of each investigation taken up. This amount expended by the State has been largely augmented by the Federal Departments through co-operative work. Thus, the State Survey has been able to accomplish a great deal more than it could possibly have done if it had been dependent simply upon its own appropriation.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

249321

CONTENTS

	PAGE
LETTER OF TRANSMITTAL	5
INTRODUCTION	9
MINERAL AND GEOLOGICAL INVESTIGATIONS	10
Mineral Investigations	10
Agreement between Federal and State Surveys	10
Gold	11
Copper	12
Monazite	12
Mineral Waters	12
Geological Investigations	13
Piedmont Geology	13
Coastal Plain Geology	13
Mountain Region Geology	14
EXAMINATION OF MINERAL SPECIMENS	14
TOPOGRAPHIC AND TRAVERSE MAPPING OF THE STATE	15
Suggested Legislation	15
GOOD ROADS	17
Suggested Legislation	18
HYDROGRAPHY	25
Stream Measurement	25
Location of Gaging Stations	25
Water Resources (Bertie County)	26
Artesian Prospects	27
Mineral Waters	27
SWAMP LANDS AND DRAINAGE	27
Swamp Area in Eastern North Carolina	30
Peat Deposits	30
Form for Description of Peat Deposits	31
FORESTRY	32
Agreement between the State Board of Education and the Geological Survey	33
Legislation recommended for Perpetuation of Forests	35
Forest Fires	36
Effect of Fires on the Forests	36
Eastern Counties	36
Central Counties	36
Western Counties	36
Damage to Trees by Fires	37
Cause of Hollows in Trees	37
Final Results of Forest Fires	38
Legislation to Protect Forests from Fires	39

PAGE

Appalachian Forest Reserve 41
Sand Banks and Dunes 41
Report on Examination of Sand Banks 42
Damage by Shifting Sands 42
Cape Hatteras Forests 43
Cape Hatteras Sand Dune Area 44
The Fixation of the Sands 45
The Coast Strip and Barrier Dune 45
Forest Station 46
Advisability of Project 47
Beaufort Inlet Project 48
Forestry Publications 48
Terracing of Farm Lands 49
MAGNETIC SURVEY 50
Magnetic Observations at North Carolina Stations 50
Early Observations at North Carolina Stations 50
FISHING INDUSTRIES 50
Oyster Cultivation 51
Clam Cultivation 52
Fishes of North Carolina 53
JAMESTOWN EXPOSITION 54
PUBLICATIONS 55
OFFICE WORK 57

M76U

NORTH CAROLINA MINERAL EXHIBIT AT THE JAMESTOWN EXPOSITION.

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

ON THE OPERATIONS OF THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY FOR THE TWO YEARS ENDING NOVEMBER 30, 1908.

By JOSEPH HYDE PRATT, State Geologist.

INTRODUCTION.

It is not possible in the Biennial Report to give more than a brief outline of the work that has been accomplished by the members of the Survey during the past two years. Detailed reports of the investigations are published as volumes, bulletins and Economic Papers, and to these the members of the General Assembly are respectfully referred.

The personnel of the North Carolina Geological and Economic Survey for the past two years has consisted of the following, who have been employed for either the whole or a part of their time:

Joseph Hyde Pratt, State Geologist.
F. B. Laney, Assistant State Geologist.
W. W. Ashe, Forester.
W. L. Spoon, Road Engineer.
E. W. Myers, Hydraulic Engineer.
J. E. Pogue, Jr., Assistant Geologist.

L. W. Stephenson,
E. W. Berry,
B. L. Miller,
Miss Julia A. Gardner,
Harvey Bassler,
} Geologists investigating Coastal Plain Resources.

R. L. Harrison,
R. C. Seitz,
M. W. Gray,
} Topographers.

R. T. Allen, Mineralogist.
A. S. Wheeler, Chemist.
Miss H. M. Berry, Secretary and Stenographer.

Besides the above, there are fourteen river observers who daily read the height of the river at their respective stations.

It is very gratifying to be able to state that Mr. W. W. Ashe has been employed as Forester and the State is to be congratulated in obtaining his services, as he is an expert forester and more familiar with the forests of North Carolina and what is needed for their protection and perpetuation than any other man.

Mr. E. W. Myers, who was formerly connected with the North Carolina Geological Survey, and then spent about eight years with the U. S. Reclamation Service, has returned to North Carolina and is now doing special work for the Survey as Hydraulic Engineer.

It is hoped that the present legislature will make it possible for the Survey to have associated on its staff several road engineers who can devote their whole time to road work in the different counties in North Carolina. Mr. W. L. Spoon, who is one of the road engineers of the U. S. Office of Public Roads, has assisted the State Survey in nearly all of its road work and has done a great deal toward the good roads cause in this State.

MINERAL AND GEOLOGICAL INVESTIGATIONS.

Mineral Investigations.

The Geological Survey continued during the past two years its investigations relating to the various mineral deposits in the State and has also gathered, in co-operation with the U. S. Geological Survey, statistics and information regarding the production of each mineral that has been mined or quarried in the State during each year. The results of these investigations have been published, as far as possible, in two of the series of Economic Papers, Nos. 14 and 15, on the Mining Industry of the State during 1906 and 1907 respectively. In these papers not only the statistics regarding the actual production of the minerals have been given, but also short descriptions of many of the mineral localities, especially new ones. Where a more complete examination and study has been made of a mineral locality, the results of such investigation are being published as separate bulletins on these subjects.

A very satisfactory arrangement has been made with the U. S. Geological Survey for co-operative work in the collecting of the mineral statistics, the following being the form of agreement:

Agreement.—For co-operation in statistical work between the United States Geological Survey and the Geological Survey of North Carolina:

In order to avoid a multiplicity of requests for statistical information from mine and quarry operations, and also in order that the State Geologist may

keep in touch with the mineral producers and the economic development of the mineral resources of the State, the following agreement between the State Geologist and the Director of the United States Geological Survey is made.

Early in the fall of each year (by October first if possible) a list of the mineral producers, as the United States Geological Survey has them, in the State of North Carolina, is to be sent to the State Geologist, who will check with the lists in the possession of the State Survey and make such corrections as he may be able to from the State Survey records. These lists will then be returned to the Division of Mineral Resources of the United States Geological Survey. Blanks for the collection of the statistics will be printed each year at the expense of the United States Geological Survey. Franked envelopes for the transmission of the statistical blanks will be addressed in the office of the Federal Survey and the blanks either numbered or, having the names and addresses of the operators written thereon, will be inclosed in the envelope with a circular letter. A franked envelope addressed to the State Geologist will be inclosed in the envelope with the circular letter and blanks, and all will then be sent to the State Geologist in order that he may inclose such additional circular to the operators as he may desire; *provided* such circular letter has been approved by the Director of the United States Geological Survey. By rubber stamp the State Geologist will indicate on the blank that the work is done by co-operation of the two surveys. On the return of the blanks to the State Geologist he will have each report carefully scrutinized and see that it is in proper form for tabulation. He will make such transcript for his own use as he may desire and then forward the reports to the United States Geological Survey.

The second and third requests for information will be prepared in the office of the Federal Survey and transmitted to the State Survey in the same manner as the first requests. The fourth requests, which are sent by registered mail, will have to be sent from Washington. After all attempts to secure returns by mail have been exhausted, the State Geological Survey will undertake to secure the reports from the delinquent operators by personal visits of himself or assistants.

In the publication of the statistical reports of the State Survey and of the United States Geological Survey, credit for the co-operative plan will be given.

(Signed) JOSEPH HYDE PRATT,
State Geologist of N. C.

Approved:
GEO. OTIS SMITH, *Director.*

In connection with the collection of these statistics relating to mineral production, a great deal of general information has been obtained and in some instances considerable field work has been done in determining something definite regarding the mineral deposit.

Gold.—In Economic Paper No. 14 there is included a report on Recent Changes in Gold Mining in North Carolina, the work on this paper being done by the State Geologist and Mr. A. A. Steel. There is also given a description of all the mines that have been operated at any time during the past three years and some idea regarding their commercial value. In Economic Paper No. 15 there is a further description of some new

gold properties and other notes on methods of mining and reduction of ores. These two papers, together with Bulletins Nos. 3 and 10, give a fairly complete account of the gold deposits of North Carolina and their possibilities.

Copper.—The investigation of the copper deposits of the State, which was commenced in 1906, has been continued and now, with the exception of a few small areas, all the copper districts have been thoroughly investigated geologically. Preliminary reports have been published of the work in the Virgilina District of Granville and Person counties, of the Gold Hill District in Rowan County, and the Swain County District. A bulletin is now in course of preparation on the Copper Ores of the Gold Hill District and later a volume will be published on the Copper Deposits of the State. These reports will be thoroughly illustrated, showing the location of the various copper deposits with plans of underground workings and maps showing the geological relation of the ore to the surrounding rocks. The field work for these reports has been done by Messrs. F. B. Laney and J. E. Pogue, Jr., under the supervision of the State Geologist.

Monazite.—The monazite area of the State has been extended during the past year by the discovery of workable deposits of monazite gravel in Alexander County. A special study has been made by the State Geologist on magnetic concentration and its application to the separation of monazite from its associated minerals. A short report on this subject is included in Economic Paper No. 15. It is now possible, by a magnetic separation, to produce a monazite sand as high as 98 per cent monazite.

Mineral Waters.—The data relating to mineral waters has been collected by the Survey office for a number of years and the analyses of these various waters that were made by chemists of the Survey and others have been brought together by the State Geologist and published as a report on the Mineral Waters of the State in Economic Paper No. 15. The mineral waters of the State offer a very promising field for investment and, while the shipment of mineral waters from the State has increased considerably during the past two years, there is still opportunity for a much larger increase in this business. One of the essential things to be done in regard to advancing the mineral water industry is a more thorough advertisement of the waters themselves.

Nearly all of the assistants of the Survey working in the field during the past year, regardless of the particular mineral they may have been working upon, were constantly collecting information regarding the occurrence of other minerals and this information is being edited at the office and will be included in the volume on the General Mineral Resources of the State.

Geological Investigations.

Special geological investigations have been made in various sections of the State in connection with the copper deposits of Davidson County and in the coastal plain region. Limited areas have also been investigated and mapped geologically in connection with the examination of different mineral localities. In the end it will be possible to prepare a geological map of the State that will show accurately the various geological formations.

Piedmont Geology.—During the summer of 1907 Messrs. F. B. Laney and J. E. Pogue, Jr., made a special study of the geology of the Gold Hill region and prepared a geological map of that section. During the field season of 1907 this work was continued into Davidson County, covering the Cid Copper District. A traverse map had been made of the district so that it was possible to make an accurate geological map of portions of those two counties. The map will cover an area of about 275 square miles. This map is now in the course of preparation and should be ready for publication sometime during the year of 1909.

The geological investigations in the Virgilina Copper District of Person and Granville counties were completed in the summer of 1907 and an outcrop map has already been published of this district.

Coastal Plain Geology.—During the field season of 1907-08, Messrs. L. W. Stephenson, E. W. Berry, B. L. Miller, Harvey Bassler and Miss Julia A. Gardner continued the geological investigations of the coastal plain region. The results of these investigations are now nearly all in manuscript form and a geological map to accompany the report has been prepared of the whole coastal plain region.

Mr. Miller has studied specially the Tertiary strata in Bladen, Carteret, Columbus, Craven, Duplin, Edgecombe, Greene, Jones, New Hanover, Pitt, Robeson, Sampson, Wayne, and Wilson counties.

Mr. E. W. Berry has finished his field work on the Cretaceous and later floras of North Carolina and assisted Mr. Stephenson by preparing a large number of reports upon specific localities for his use in stratigraphic work and in completing his work on the Cretaceous. He has also collected Tertiary plants from certain localities for Mr. Miller. He has completed the identification and illustration and characterization of the species collected. In all, about seventy species from twenty-one different localities within the Cretaceous belt have been discovered; about a dozen Tertiary species from three different localities; and a large Pleistocene flora from two different localities.

In connection with this work on the coastal plain region, there will be included in the volume a general report on the stratigraphy, underground

water supplies and a description of the peat and swamp lands. In connection with the underground water resources, each county will be taken up separately and discussed and statements made regarding the probability of obtaining artesian water and at what depths.

Mountain Region Geology.—Detailed geological work has been carried on in western North Carolina by F. B. Laney of the State Survey and Mr. Arthur Keith of the U. S. Geological Survey. Mr. Laney has made a study of the geological relations of the copper ores of Jackson County in the vicinity of Cullowhee. The field work of the U. S. Geological Survey is published in the form of geological folios and one of these, the Roan Mountain, has been published during the past two years. This folio covers portions of Mitchell and Yancey counties. The field work on a number of other sheets has been completed and it is expected that these will be published in the near future.

EXAMINATION OF MINERAL SPECIMENS.

The work that was undertaken in 1906 by the State Survey in cooperation with the United States Geological Survey regarding the mineralogical character of the black sands found in the southern Appalachians was continued until July 1, 1907, when the appropriation for this work by the Geological Survey ceased. The State Survey has, however, continued the work, although not on as large a scale as formerly. During these two years 609 samples have been examined and their commercial value determined. On many of these samples magnetic separations were made of the minerals and the percentage of each determined. The equipment that was reported in the last report is still installed in the concentrating plant at Chapel Hill, but, as stated above, on account of lack of funds, it has not been possible to utilize the plant as fully as it otherwise would have been.

It is impossible to make assays or chemical analyses free of charge, as the Survey has no special appropriation for this kind of work. Any mineral specimens, however, that are sent into the office will be examined and identified without any cost to the one sending the samples. There will also be given information as to the probable value of the sample and whether, in the opinion of the Survey office, an assay or further analytical work would be of any advantage. While in the field, the State Geologist and his assistants have examined a great many samples of minerals for different people and thus the actual number of mineral specimens determined for various people throughout the State is largely in excess of that mentioned above.

TOPOGRAPHIC AND TRAVERSE MAPPING OF THE STATE.

All the topographic and traverse mapping that has been done in North Carolina during the past two years has been by the U. S. Geological Survey and largely in co-operation with the North Carolina Geological and Economic Survey. All topographic mapping requires first that a base or traverse map be made and as many of the counties are very anxious to have county traverse maps, arrangements have been made by the State Survey to co-operate with the different counties by which these traverse maps can be prepared in advance of the topographic maps by men detailed from the U. S. Geological Survey. These base or traverse maps are kept on file by the U. S. Geological Survey and just as fast as possible they will be utilized in completing the topographic maps. These traverse maps, which are of value to the counties for educational work and in connection with good roads work, have been paid for in part by the county, and in part by the State Geological Survey. Thus far, Granville, Pitt and Beaufort counties have made arrangements for the preparation of such maps. The Granville County map is now nearly ready to go to the press. The field work on the Beaufort County map will be completed about the middle of December and the Pitt County map will be ready for the engraver at an early date. The value of these maps is being appreciated more and more all the time and their demand is increasing. Applications are constantly being made to the U. S. Geological Survey by North Carolina members of Congress for topographic mapping in their districts, but only a very small proportion of the applications made can be granted on account of the lack of funds. At the present rate of mapping of the State, it will be many years before a complete map of North Carolina will have been prepared and, considering the demand for the map and its value to the State, the State Geologist would recommend that a special appropriation be made for topographic mapping in North Carolina.

SUGGESTION REGARDING AN ACT AUTHORIZING THE STATE GEOLOGIST TO CO-OPERATE WITH THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY IN MAKING A TOPOGRAPHIC SURVEY AND MAP OF THE STATE OF NORTH CAROLINA, AND MAKING AN APPROPRIATION THEREFOR.

The General Assembly of North Carolina do enact:

SECTION 1. That in order to continue the execution and speedy completion of a topographic survey and map of this State, the State Geologist is hereby authorized to confer with the Director of the United

States Geological Survey and to accept the co-operation of the United States with this State in the execution of a topographic survey and map of this State, which is hereby authorized to be made; and that said State Geologist shall have the power to arrange with said Director of the United States Geological Survey, or his authorized representative, concerning the details of the said work, the method of its execution, and the order in point of time in which these surveys and maps of different parts of the State shall be completed: *Provided,* that the said Director of the United States Geological Survey shall agree to expend on the part of the United States upon said work a sum equal to that hereby appropriated for this purpose; *Provided,* also, that this sum is in excess of such sum as would be spent in the State for topographic mapping without any co-operation on the part of said State. In arranging the details heretofore referred to, the State Geologist shall, in addition to such other provisions as he may deem wise, require that the maps shall show the outlines of all counties, townships and extensive wooded areas, as existing on the ground at the time of the execution of the surveys; the location of all roads, streams, canals, lakes and rivers, and shall contain contour lines showing the elevation and depression, with vertical intervals of from ten to one hundred feet as may be hereafter mutually agreed upon by the said State Geologist and the said Director of the United States Geological Survey: *Provided,* also, that the resulting map shall fully recognize the co-operation of the State of North Carolina, and that as each manuscript sheet of the map is completed the State Geologist shall be furnished by the United States Geological Survey with photographic copies of the same, and as the engraving on each sheet is completed, the State Geologist shall be furnished by said Director with transfers from the copperplate of the same: *Provided,* further that the cost of engraving shall not be included in the sum that the said Director of the United States Geological Survey shall agree to expend in the State on the part of the United States.

SEC. 2. The sum of ten thousand dollars annually for six years, or so much thereof as may be necessary for carrying out the purposes of this act, is hereby appropriated out of any moneys in the treasury of the State not otherwise appropriated to be drawn upon as directed by the Geological Survey Board.

SEC. 3. This act shall be in force and effect after its ratification.

The following topographic maps have been completed during the past two years and are, or will be, in a few weeks ready for distribution: Beckford, Four Oaks and Winton Quadrangles covering portions of

Chowan, Gates, Hertford, Perquimans, Johnston, Wayne, Sampson, Harnett and Bertie counties, the area surveyed being 353 square miles, published on the scale of 1: 62,500 and with a contour interval of 10 feet.

The Great Coharrie Quadrangle in Sampson County was completed during the spring of 1908 and is now nearly ready for distribution.

The Gaffney Quadrangle, covering a part of Cleveland County, was also completed. These two sheets cover an area of 344 square miles and are published on the scale of 1: 62,500.

Traverse maps have been made of Granville and Beaufort counties and portions of Person, Rowan, Cabarrus, Stanley and Davidson counties.

GOOD ROADS.

Although but few of the counties of North Carolina are as yet constructing graded macadam roads, there are over half of them that are interested in one way or another in the construction of improved roads. Unfortunately, there are a large number of our people who are still not conversant with the good roads problem and do not realize the great advantages that a community derives from them. It is true, however, that the progressive men of the State who are working for industrial advancement realize most emphatically that one of the greatest causes that is retarding this advancement is the lack of good roads. Public roads are public necessities and the educational as well as the industrial advancement of the State is vitally dependent upon them. The work of good roads construction in the State would be greatly facilitated by State aid and it is the opinion of the State Geologist that there should be some co-operation on the part of the State with the counties.

First, because, as stated above, the public roads are public necessities and are ready to serve all classes. They represent common property of all the people and all the people have the right and privilege of using them.

Second. In connecting country with town, a good macadam road would often be traversing two or three counties so that in obtaining the best results from good roads they become inter-county questions.

Third. The construction of macadam road means an increased valuation of property along the road, which, in turn, means an increased revenue to the State as well as to the county.

Fourth. Educational facilities in the rural districts are dependent upon good roads and, where these exist, it is entirely feasible to substitute for a little school house of one room and one teacher a consolidated or graded school of half a dozen rooms and half a dozen teachers. A school house of one room and one teacher was good but a graded school

of six rooms and six teachers is vastly superior and can be secured for the children of all the counties of the State if good roads are built in these counties. The consolidated or graded school is dependent upon graded roads and as the State, through its State Board of Education, has supervision over the schools, it is interested in the construction of good roads.

Fifth. Pleasure seekers and tourists from North Carolina and outside the State are specially interested in a system of good graded roads throughout North Carolina.

For these reasons, the problem of good roads construction in North Carolina becomes a State as well as a county problem.

The State can make no better investment than in the actual construction of good roads and, while it is not advocated that the State shall entirely build any piece of road in any particular district, it is strongly advocated that the State appropriate sufficient funds to enable it to co-operate with those counties which are willing to appropriate a like amount of money for the construction of good roads in the county. The following legislation was suggested at the Good Roads Congress held in Greensboro, October 14, 1908, and was approved by the N. C. Good Roads Association and the Geological Board:

Suggested Legislation for Establishing a State Highway Commission Defining the Powers of the Commission and the Duties of the Highway Engineer.

The General Assembly of North Carolina do enact:

Section 1. A State Highway Commission is hereby established, which shall consist of the State Geologist; the Commissioner of Agriculture; Professor of Civil Engineering in the University of North Carolina; Professor of Civil Engineering in the North Carolina College of Agriculture and Mechanic Arts; and one member of the Geological Survey Board.

Sec. 2. The Highway Commission shall appoint a competent civil engineer, who is experienced in the construction and maintenance of improved roads, as State Highway Engineer for a term of four years and until his successor is appointed. Said Highway Engineer shall receive a salary of two thousand five hundred dollars per annum, and shall be allowed his travelling expenses while officially employed. He shall furnish a bond in the sum of twenty-five hundred dollars for the faithful performance of his duty, said bond to be approved by the Governor, and he shall give his whole time and attention to the duties of his office. The

Highway Commission may appoint, as the work of the department requires, assistant engineers who shall be capable and competent civil engineers and experienced in road building, and other assistants, clerks and stenographers as may be required to carry out the provisions of this act, whose compensation shall be determined by the Highway Commission.

SEC. 3. The object and purpose of this Commission shall be to instruct, assist and co-operate in the building and improvement of the public roads, under the direction of the Highway Engineer, in such counties and townships of the State of North Carolina as shall comply with the provisions of this act. The Highway Commission may make inquiries in regard to systems of road building and management throughout the United States, and make investigations and experiments in regard to the best methods of road making and the best kinds of road material; and prepare, publish and distribute bulletins and reports on the subject of road improvement; and the Highway Engineer shall also gather and tabulate information and statistics on road building in North Carolina and disseminate the same throughout the State. The Highway Commission shall make a biennial report to the legislature of the work of the department.

SEC. 4. In order to obtain the benefits of this act, the County Commissioners in any county in this State may, at any time, by resolution, request the Highway Commission that any public road or section of road, located within said county, being at least one mile in length, or, being less than one mile in length, if an extension or connection with some permanently improved or paved street, or permanently improved highway of approved construction, be improved by the construction of a macadamized road, or a telford or other stone road, or a road constructed of gravel, brick or other suitable material, in such manner that the same, of whatever material constructed, shall, with reasonable repairs thereto, at all seasons of the year, be firm, smooth and convenient for travel; or whenever a road or section or improvement thereof is petitioned for by the owners of 51 per cent of the lineal feet along said road, or section thereof, praying the Board of County Commissioners to cause such roads to be improved under this act, it shall be the duty of the Board to make such request to the Highway Commission, if after viewing such road said Board of County Commissioners shall decide the improvement of such road to be just and to the best interest of the public, subject to the conditions as hereinafter provided. When more roads are applied for than can be constructed in one year, the Board of County Commissioners and Highway Engineer shall have power and authority to select from the roads petitioned for, the ones first to be constructed, having first regard

to the most important roads and the distribution of the benefits of this act to all parts of the county.

SEC. 5. The Highway Engineer shall, upon receipt of any such application, investigate and determine whether the highway or section thereof sought to be improved is of sufficient public importance to come within the purpose of this act, taking into account the use, location and value of such highway or section thereof for the purpose of common traffic and travelling, and after such investigation, shall certify his approval or disapproval of such application. If he shall disapprove such application, he shall certify his reasons therefor to the Board of County Commissioners making the application.

SEC. 6. If the Highway Engineer shall approve of such application, he shall cause the highway or section thereof, therein described, to be mapped both in outline and profile. He shall indicate how much of such highway or section thereof may be improved by deviation from or alteration of the existing lines whenever it shall be deemed of advantage to obtain a shorter or more direct road without lessening its usefulness; or whenever such deviation or alteration is of advantage by reason of lessened gradients, and shall cause plans and specifications of such highway or section thereof to be made for telford, macadam or gravel roadway, or other suitable construction, taking into consideration the climate and soil, and the material to be had in the vicinity thereof, and the extent and nature of the traffic likely to be upon the highway, specifying in his judgement the kind of road a wise economy demands The improved or permanent roadway of all highways so improved shall not be less than eight nor more than sixteen feet in width, unless for special reasons to be stated by such Highway Engineer it is required that it shall be of greater width. All highways improved under the provisions of this act shall conform to the standard of construction established by the State Highway Department.

SEC. 7. Upon the completion of such maps, plans and specifications of a proposed improvement the State Highway Engineer shall cause an estimate to be made of the cost of construction of the same, and transmit the same to the Board of County Commissioners from which such resolution proceeded, together with a certified copy of such maps, plans and specifications, and of his certificate of the approval of the highway or section thereof so designated as aforesaid.

SEC. 8. After the receipt thereof upon a majority vote of such Board of County Commissioners, it may adopt a resolution that such highway or sections thereof so approved shall be constructed under the provisions

of this act, or of any existing act, and thereupon shall transmit a certified copy of such resolution to the State Highway Engineer.

SEC. 9. In case such proposed highway shall deviate from the existing highway, the officials making application must provide for securing the requisite right of way by condemnation proceedings or otherwise, prior to the actual commencement of the work of improvement, and shall secure release from damage to property by reason of change of grade.

SEC. 10. That upon the receipt of the application and certified copy of the resolution provided for in Section 7 the State Highway Engineer shall advertise for bids for two successive weeks in one newspaper of general circulation, published in the county in which the road is to be built, according to said plans and specifications which shall be on file at the County Commissioner's office and shall award such contract to the lowest responsible bidder, subject, however, to the approval of the County Commissioners. No contract shall be awarded at a greater sum than the estimate provided in Section 7; *Provided,* that when bids are received for such improvement, they shall be sealed bids and shall be protected with such other regulations as may be imposed by the County Commissioners, necessary to secure fair bids. But if no bid otherwise acceptable be made within such estimate, such Highway Engineer may amend his estimate, certify the same to the Board of County Commissioners and upon the adoption by it of a resolution as provided in Section 6, based on such amended estimate, proceed anew to obtain bids and award the contract as herein provided. Said County Commissioners may reject any and all bids and before entering into any contract for such construction shall require a bond with sufficient sureties, or by a surety company of recognized standing, conditioned that if the proposal shall be accepted the party thereto will perform the work upon the terms proposed and within the time prescribed and in accordance with the plans and specifications; and as a bond of indemnity against any direct or indirect damage that shall be suffered or claimed during the construction of such road and until the same is accepted. The State of North Carolina shall in no case be liable for any damages suffered.

SEC. 11. Upon the completion of any highways rebuilt or improved under the provisions of this act, the Highway Engineer shall immediately ascertain the total cost and expense of the same and apportionment of the total cost and expense between the State and the county, and the Highway Engineer shall certify the total expense of said improvement to the County Commissioners, signifying the amounts contracted to be borne by the State and the county.

SEC. 12. One-fourth of the cost and expense of the construction

thereof shall be paid by the Treasurer of the State of North Carolina on the warrant of the State Auditor issued upon requisition of the State Highway Engineer, approved by the Chairman of the North Carolina Highway Commission, out of any specific appropriations made to carry out the provisions of this act, and three-fourths of the cost and expense thereof shall be a county charge in the first instance and shall be paid by the Treasurer of the county in which such highway or section thereof is located upon the order of the County Commissioners upon the requisition of the State Highway Engineer out of any funds in the county treasury for the construction of improved highways under the provisions of this act; *Provided,* that not more than five thousand dollars shall be paid by the State for highway construction work in any one county in a single year.

SEC. 13. No money shall be advanced by the State of North Carolina or by the County Commissioners in payment of the cost and expense of construction provided herein except as the work of actual construction progresses to be paid upon estimates made by the engineer in charge of the work, and in no case shall the payment or payments of the State of North Carolina and the County Commissioners made thus prior to the completion of the work be in excess of eighty per centum of the value of the work performed, and in all cases twenty per centum must be held until the completion of the work, according to the plans and specifications, and every county or township availing itself of the provisions of this act shall, because of having accepted such State aid, contract and bind itself to maintain and keep said road in good and efficient repair, for the free use of the public.

SEC. 14. Every contract authorized to be made by the State Highway Commission, under the provisions of this act, shall be made in the name of the State of North Carolina, and shall be signed by the Highway Engineer and attested by the Chairman of the Highway Commission, and must be approved by the Board of County Commissioners of the county in which the improvement is to be made; *Provided* further, that no contract for any highway improvement shall be let by the State Highway Commission, nor shall any work be authorized under the provisions of this act, until the written agreement of the County Commisioners of the county in which the proposed improvement is to be made agreeing to assume their respective share of the cost thereof, as hereinbefore provided, shall be on file in the office of the State Highway Department, and shall have been approved as to form and legality by the Attorney-General.

SEC. 15. The construction and improvement of highways and sections thereof under the provisions of this act shall be taken up and carried

forward in the order in which they are finally designated, as determined by the date of the receipt in each case of the certified copy of the resolution provided in Section 8 by the Highway Engineer as hereinbefore provided.

SEC. 16. The County Commissioners, or County Road Commissioners, when such exist, shall have the authority to select the kind of materials to be used in improving any road under the provisions of this act. The State Highway Engineer shall furnish to the County Commissioners information as to the probable cost of improved highways, as defined in this section.

SEC. 17. Counties may agree among themselves to contribute their combined proportion of the total expense of construction, herein provided, to be borne by them for the construction of County Line Roads in any proportion agreed upon by the several Boards of County Commissioners, but in no case shall any county pay less than ten per centum of the entire expense of such improvements.

SEC. 18. Whenever any turnpike or improved road now constructed is in need of reconstruction, it may be done under the provisions of this act in the same manner as provided for herein for the construction of new improved roads, and all provisions herein applying to the construction of improved roads shall apply to such reconstruction of roads, and such roads must be reconstructed in accordance with the provisions herein.

SEC. 19. The money appropriated from time to time by the State of North Carolina for the purpose of carrying out the provisions of this act shall not be used in any other manner or for any other purpose than as herein provided; *Provided,* that the amounts appropriated shall be divided among the counties of the State in proportion to the amount of State taxes that each county pays into the State Treasury, but the said amount apportioned to each county shall remain in the State Treasury until applied for under the provisions of this act; *Provided* further, that if not applied for by the county to which they have been allotted by the first day of July of each year, such amounts shall be re-apportioned among those counties which have applied for aid; *Provided* further, that on the first day of January of each year any amounts remaining unapplied for by the counties shall be added to the regular appropriation for the ensuing year and be apportioned among the counties as provided above as their allotment for that year.

SEC. 20. The State Highway Commission shall meet twice a year, once in June and again in January, at the call of the Chairman of the Commission. The members of the Commission, except the State Geolo-

gist and Commissioner of Agriculture, shall receive four dollars per diem and all the commissioners shall be allowed their actual expenses in attending these meetings, which amounts shall be paid out of the Highway Commission fund.

SEC. 21. The said Highway Engineer shall make semi-annual reports to the Highway Commission at their regular meetings on the progress of his work and the financial condition of his department.

SEC. 22. The sum of $150,000 annually is hereby appropriated out of any moneys in the Treasury not otherwise appropriated for the purpose of carrying out the provisions of this act.

SEC. 23. Nothing in this act shall be construed to be in conflict with any act now in force.

SEC. 24. This act shall be in force from and after its ratification.

The Geological Survey has been attempting, as far as possible, to give assistance in regard to the location of roads and the best methods of constructing same in the various counties. Numerous addresses have been made in the counties regarding the value of public roads and best methods of constructing same. In co-operation with the Office of Public Roads of the United States Department of Agriculture, the State Survey has been enabled to arrange for special lectures on various phases of good roads work, which have been delivered at Andrews, Asheville, Bayboro, Brevard, Bryson City, Camden, Columbia, Columbus, Creswell, Edenton, Elizabeth City, Franklin, Gatesville, Greenville, Greensboro, Haysville, Hendersonville, Hertford, Marion, Maysville, Moyock, Murphy, Plymouth, Newbern, Richmond, Robbinsville, Rutherfordton, Shiloh, Washington, Williamston, Waynesville and Webster. Special inspection was also made of several roads in the course of construction, including in some instances a survey and the preparation of specifications and estimates. This included a sand-clay road near Clinton, Sampson County; a macadam road leading from Tryon to Lynn, Polk County; a macadam road from Spray to Leaksville, Rockingham County; a graded dirt turnpike from North Wilkesboro, Wilkes County, to Jefferson, Ashe County; a proposed object lesson of macadam road at Shelby, Cleveland County and Windsor, Bertie County; survey and estimate of cost of macadam road at Hillsboro, Orange County; the inspection of local conditions as to kind of roads to be built at Southport, Brunswick County; and an inspection regarding the best method of improving the streets of Greenville, Pitt County. Mr. W. L. Spoon has done most of the work referred to above. The State Geologist has given a number of the addresses.

HYDROGRAPHY.

Stream Measurement.

In co-operation with the U. S. Geological Survey, considerable work has been done in connection with the various problems relating to water supply and water power in North Carolina. There were maintained during the past two years thirty gaging stations, of which the State is paying the salaries of twelve of the gage readers and the U. S. Geological Survey the balance. These stations are located as follows:

Gaging Stations Maintained in North Carolina by U. S. Geological Survey and North Carolina Geological and Economic Survey.

	River.	Locality.	County.
1.	Broad.	Uree.	Rutherford.
2.	Catawba.	Morganton.	Burke.
3.	Cullasaja.	Cullasaja.	Macon.
4.	Cheoah.	Millsaps.	Graham.
5.	Dan.	Madison.	Rockingham.
6.	Davidsons.	Davidsons.	Transylvania.
7.	French Broad.	Asheville.	Buncombe.
8.	French Broad.	Rosman.	Transylvania.
9.	Green.	Saluda.	Polk.
10.	Hiwassee.	Murphy.	Cherokee.
11.	Hiwassee.	Hayesville.	Clay.
12.	Linville.	Fonta Flora.	Burke.
13.	Little River.	Calhoun.	Alexander.
14.	Little Tennessee.	Judson.	Swain.
15.	Little Tennessee.	Franklin.	Macon.
16.	Nantahala.	Nantahala.	Swain.
17.	N. Fork Mills.	Pinkbed.	Henderson.
18.	S. Fork Mills.	Sitton.	Henderson.
19.	North Toe.	Spruce Pine.	Mitchell.
20.	Oconalufty.	Cherokee.	Swain.
21.	Pigeon.	Canton.	Haywood.
22.	Scotts Creek.	Dillsboro.	Jackson.
23.	Second Broad.	Logans Store.	Rutherford.
24.	Swannanoa.	Swannanoa.	Buncombe.
25.	Tuckaseegee.	Bryson City.	Swain.
26.	Tuckaseegee.	East Laport.	Jackson.
27.	Tusquitee Creek.	Hayesville.	Clay.
28.	Valley River.	Tomotla.	Cherokee.
29.	Yadkin.	N. Wilkesboro.	Wilkes.
30.	Yadkin.	Salisbury.	Rowan.

Besides the daily gage readings of the height of the water in the streams, there has been made at intervals during the past two years discharge measurements, which give the actual amount of water passing

the station each minute. The data obtained at these stations are used in determining the value of the waterpowers on the various streams and rivers. In co-operation with the Federal Survey, a nearly complete report on the waterpowers of the State has been prepared and the manuscript is now being edited. The waterpowers of the State are one of its most valuable resources and this State should take every precaution to maintain these and it is of the most vital importance that the forests on the mountain slopes in which these streams have their sources should be protected, if the waterpowers are to be kept at their present efficiency.

There has also been prepared a report on the Water Resources of the Coastal Plain Region which is already in manuscript form and will be published as part of the volume on the coastal plain region of the State. In this report descriptions are given of each county in eastern North Carolina regarding its water resources and there is given below the description of Bertie County which will illustrate the scope of the report.

Water Resources (Bertie County).—The lower sandy portions of the Pleistocene formations furnish the greater part of the supply of water for domestic use. Driven wells are gradually taking the place of open wells and, with the exception of Aulander, the villages now contain more of the former than the latter. The wells range in depth from 8 to 35 feet with a very few as deep as 60 feet. Those exceeding 35 feet derive their water from the underlying Miocene. The water from the Pleistocene beds is almost everywhere soft, although in places it is ferruginous. Many springs occur along the scarps and in the stream valleys, but they are small and unimportant.

But few deep wells have been drilled in Bertie County. Seven or eight years ago at Windsor a 2½-inch pipe was sunk 250 feet, obtaining a small flow which, after continuing for about three months, suddenly stopped, due to the entrance of sand into the pipe. In 1905 a deep well was drilled for the town near the one above described. The elevation of the mouth of the well above sea-level is about 10 feet. A small flow was obtained at a depth of 250 feet and an 8-inch casing was driven to that depth and drilling continued, using a 6-inch casing. At 560 feet a flow of approximately 10 gallons per minute was obtained, but was lost either by caving or by casing past the water stratum. Ten feet deeper, at 570 feet, a flow of 4 gallons per minute was struck. This flow was also lost. Drilling was continued to a depth of 585 feet, but no other water-bearing beds were penetrated. An attempt was made to pull up the 6-inch casing, but it parted about 10 feet below the bottom of the 8-inch casing, and only the upper 260 feet was withdrawn. The water from the 250-foot horizon contains sodium bicarbonate and has a strong

sulphur odor and taste. The three flows obtained were probably from the Cape Fear formation which underlies the Miocene.

An attempt to get a flowing well was made about three years ago in Lewiston. A 2-inch pipe is reported to have been sunk 164 feet where drilling was stopped by quicksand. Water struck at about 100 feet rose to within a few feet of the surface. This well probably passed through the Miocene and entered the Cape Fear beds. At Avoca a pipe was driven to a depth of 180 feet without securing a flow of water. At this depth quicksand interfered so seriously with the progress of the work that the undertaking was abandoned.

Artesian Prospects.—Abundant supplies of potable water may be obtained from the Miocene and Cape Fear deposits underlying the county. It is believed that the depths at which the water-bearing beds will be encountered will vary considerably in the different parts of the county. At Windsor, in the south central part, a flow of sodium bicarbonate water was found at 250 feet. Stronger flows were found at 560 and 570 feet. In the western part of the county the depth to these horizons will be considerably less. Bed-rock would probably be encountered 500 to 600 feet below the surface in the extreme northwestern corner. The water from deep wells in the central and western parts of the county will be high in sodium bicarbonate, with considerable amounts of chlorine and sulphates. In the eastern portion of the county water-bearing horizons in the Miocene yielding a somewhat harder water would probably be penetrated at depths ranging from 35 to 400 or 500 feet below the surface. With the exception of Windsor, none of the larger towns are situated favorably for obtaining flowing wells. It is doubtful if any well drilled within the county will overflow at elevations of over a few feet above sea-level.

Mineral Waters.—A preliminary investigation has been made upon the mineral waters of North Carolina and many samples have been collected and analyzed. The results of this investigation are published in Economic Paper No. 15 on the Mining Industry in the State for 1907.

SWAMP LANDS AND DRAINAGE.

Another line of investigation that has been taken up during the past two years is the investigation of the swamp lands of North Carolina. While only a preliminary start has been made in this work, it still has attracted a great deal of attention and bids fair to become one of the more important works of the Geological Survey. Several preliminary examinations were made in 1907 of various swamp lands to determine:

First. The character of the swamp, whether the soil was suitable for agricultural purposes or whether it was too peaty in character.

Second. Whether the peat swamps contained this material in quantity and of such quality that it could be marketed.

Third. Whether the swamps could be drained.

Several areas were examined in Bladen, Carteret, Craven, Duplin, Onslow, Pasquotank, Pender and Wilson counties. Some of these showed areas of peat of commercial quality and quantity and others showed swamps, the soil of which is adapted to agricultural purposes when drained. These swamp lands have attracted the attention of investors for many years, as their value for agricultural purposes was recognized. One of the drawbacks to those swamp areas that were covered with timber was the cost of clearing. Now, however, since the timber itself has become of such value that its removal is profitable, it has reduced the cost of clearing. Also the advance made in dredges and methods of drainage makes it now possible to drain these large areas of swamp land at a figure commeasurable with the increased value of the land itself. Where the swamp lands are composed of thick beds of peat, their agricultural value is not very large, on account of the cost of preparing the land and bringing it into a state of cultivation. This is due to the large amount of water held mechanically by the peat, which in time causes a shrinkage or settling of the land; the very large percentage of humus; and lack of other available constituents that are necessary to make good crops. There are, however, many of our swamp areas where the percentage of peat is low, but still in sufficient quantities to give the right amount of humus to the land, after it is drained, and making very rich and productive soils. As an illustration of the value of some of our swamp lands after they have been drained, I would like to state what has actually taken place during the past year at one locality in North Carolina.

About five miles southeast of Pinetown, Beaufort County, a canal has been constructed through one of our large swamp areas for a distance of five miles and having a width of thirty feet and depth of seven feet. Before this canal was begun, the people living in the vicinity of the swamp all claimed that it would be impossible to drain the swamp as there was not sufficient fall to take care of the water. The ones who were interested in the project, however, had had a survey made of the swamp and were confident that there was a sufficient fall along the line of the canal to take care of all the water and drain the land. As the canal was being constructed, it was found necessary at the end of a mile to construct a retaining dam six feet high in order to keep sufficient water in the canal to float the dredge. After another mile and a quarter of the

canal had been constructed, it was found necessary to build another dam six feet high. After the five miles of canal had been constructed, the total fall in that distance was found to be a little over 12 feet. The dredge was then taken back down the canal and the dams removed. During the extreme heavy rains of the past summer in eastern North Carolina, this canal was able to take care of all the excess water, and, as far as I could ascertain, it never rose over 15 inches in the canal. Last spring, in order to determine the actual agricultural value of the land drained, 10 acres bordering on the canal were cleared by cutting down the trees and underbrush and burning them, leaving the stumps. Corn was planted by means of a hand-drill made out of a piece of hollow gum wood. There was no opportunity for plowing the field, so the corn was planted by simply running the drill into the ground and dropping the seed. It was also impossible to cultivate the corn as it was growing, on account of the stumps. The fires, however, had destroyed all of the undergrowth so that there were no weeds to interfere with the growth of the corn. This tract produced an average of 40 bushels of corn to the acre, which will give an idea of the great value of this land for agricultural purposes. With the construction of lateral canals, this main canal will be capable of draining from 6,000 to 7,000 acres. Another advantage gained by the drainage of these swamp lands is the construction of a good system of roads along the banks of the canals. In connection with the canal just referred to, a road bed has been made along its bank.

A complete survey has been made of Angola Bay swamp in Pender and Duplin counties and plans and specifications drawn up for its drainage. This work was done by the Drainage Division of the U. S. Department of Agriculture.

The results of this preliminary work have aroused a great deal of interest in regard to the drainage of swamp lands and this culminated in a Drainage Convention which was held at Newbern, September 9 and 10, 1908. At this convention there were present about seventy delegates from Beaufort, Bladen, Brunswick, Camden, Carteret, Columbus, Craven, Currituck, Greene, Guilford, Harnett, Hyde, Jones, New Hanover, Onslow, Orange, Pamlico, Pasquotank, Pender, Pitt, Wake, and Washington counties. A most enthusiastic convention was held which resulted in the drafting by the convention of a bill regarding drainage that it is hoped the General Assembly of 1909 will adopt. The proceedings of this convention are published in Economic Paper No. 17.

The estimated swamp area in eastern North Carolina is 4,505 square miles divided approximately as follows:

SWAMP AREA IN EASTERN NORTH CAROLINA.

County.	No. sq. miles.	County.	No. sq. miles.
Beaufort	177	Jones	139
Bertie	57	Martin	86
Bladen	192	New Hanover	25
Brunswick	300	Onslow	134
Camden	162	Pamlico	325
Carteret	126	Pasquotank	80
Chowan	30	Pender	370
Columbus	300	Perquimans	92
Craven	238	Pitt	40
Cumberland	30	Robeson	130
Currituck	40	Sampson	18
Dare	344	Tyrrell	251
Duplin	125	Washington	262
Gates	45		
Hyde	387	Total No. square miles	4,505

Peat Deposits.—Many of these areas are not suitable for agricultural purposes, even if they were drained; other areas offer too great mechanical difficulties in drainage to make it practicable; still others are more suitable for growing timber than for other agricultural purposes; and still others contain deposits of peat from a few feet to nearly 20 feet in depth. While some of these can be reclaimed for agricultural purposes, they offer difficulties in the way of bringing the land itself into the condition that it will produce crops. Some of these contain good peat of commercial quality from 10 to 15 feet deep which is very free from roots, stumps, sand, etc. One of these on the outskirts of Elizabeth City, Pasquotank County, was tested and two carloads of the peat collected and shipped to the Fuel Testing Plant of the U. S. Geological Survey, located in the Jamestown Exposition grounds. Here an examination was made as to its quality. It contained over 50 per cent of water but, for peat, was low in ash and it will make a good fuel. The value of peat as a fuel is well recognized and, as it burns without soot, with little smoke and leaves practically no clinkers, it makes a very clean fuel, especially for domestic purposes. It can also be used for metallurgical purposes and boilers. It is undoubtedly true that where peat is used as a fuel under boilers that the boilers will last considerably longer than where coal is the fuel used.

Perhaps the main reason why the peat of North Carolina and other portions of the United States has not been utilized as a source of fuel is that other forms of fuel have been so abundant and could be produced so cheaply that there has been no apparent necessity for attempting to utilize peat, and, therefore, but little attention has been given to this

fuel. With, however, the large demand that has been made upon the coal supplies of this country and the warning that has been given in regard to their waste and need of conservation, government and State officials have begun to look for other sources of fuel and peat is claiming their attention.

There is one method for the utilization of peat that may prove of considerable value to North Carolina, which is the establishment at the peat bog of either a gas producer and electrical generator; or boiler, dynamo and generator and thus produce electric power at the bog, transmitting same to the nearby towns for lighting and power purposes. These plants could be made as small as the requirements of the town call for, but so arranged that they could be readily increased with the demand for additional power. It is absolutely necessary, before undertaking the operation of a peat deposit, to determine first the quality of the peat, whether it is of such grade that it will make a fuel of commercial value; second, the extent of the deposit, whether it is of sufficient area to warrant the establishment of a plant for preparing it for market; third, the determination of the cost of digging, drying and preparing the peat for market.

The Survey will be glad to examine samples of peat and, in sending them in, it is earnestly requested that as much information as possible be given regarding the peat deposit, its area, depth, location, etc. The following scheme for description of peat deposits is used by the Survey and the one sending the sample should fill out the blank as fully as possible:

FORM FOR DESCRIPTION OF PEAT DEPOSITS.

1. Exact location, county, distance from nearest large town, roads by which it may be reached.

2. Distance from the nearest railroad and boat lines. (Character of wagon roads nearby.)

3. Address of owner or agent.

4. Approximate area of the surface.

5. The character of the surrounding lands (cleared or wooded, swampy or dry).

6. Type of deposit: (a) Flat, undrained area (pocosen type); (b) Marginal to stream or sound; (2) Basin, deep or shallow.

7. The kind of plant growth on the surface of the deposit (grasses, sedges, nearly pure or mixed with other herbaceous types, reeds or cane, shrubs and moss, or trees, etc. If trees have been cleared or burned off, note, with kinds removed, if this can be determined, and the condition of stumps and roots, whether sound or rotten.

8. Possibilities of drainage, slope of surface of peat, streams through the bog or near by it.

9. (a) Character and thickness of the surface layer to good peat; (b) Depth of the whole deposit. For reconnaissance work, a small deposit may be tested by a single line of holes along axis of the bog. Shallow, 4 ft. or less, deposits, even if of large area, have little value unless very pure.

10. The amount of decomposition of the lower layers of the peat below the surface litter should be determined by examination of samples carefully taken, and the acidity, color, plasticity and odor noted as well as any change of color or of other properties after exposure to the air. (Litmus paper should be used to test acidity.) The lower layers of peat formed in wet basins usually of different origin from the upper, and of different structure.

11. Presence of logs, stumps and other coarse vegetable matter, and of layers of clay, sand or stones, at any depth, must always be noted, as well as the condition or decomposition of the former.

12. The kind of material below the peat, whether gravel, sand, clay or marl. Very wet clay will be about as penetrable as peat, hence, where found, samples must be taken carefully to determine the depth of peat.

13. Final sampling should include more careful testing of (a) uniformity of texture of the various beds; (b) purity and freedom from logs and other obstructions; (c) depth to and at which these occur, if this is uniform; (d) the extent of the beds in area and thickness; (e) the plasticity of the peat, coarseness and degree of decomposition; (f) color, whether light, brown or black; (g) depth to the various types found.

14. Samples should be taken from each hole made to show the character of the different strata encountered. Samples from different depths should be kept separate and each labelled. Those from the same depth from different holes in the same deposit may be mixed. Two samples, a small wet one, placed in a water-tight container, preferably the wooden mailing case, and a larger one to be put in a cloth bag, where it may be allowed to dry out before shipping.

15. When the sounder meets an obstruction, it is always better to pull it up and push it down in another place than to try to force it through the obstruction at the risk of breaking the rod and losing the sounder. There should be no deviation from this rule.

A preliminary examination has been made of the peat deposits by Prof. Charles A. Davis of the U. S. Geological Survey and the results are published in Economic Paper 15.

The State Geologist was instrumental in organizing the American Peat Society, and was elected President of the Society. A quarterly journal is being published that is very materially assisting the peat industry.

FORESTRY.

Considerable advance has been made in forestry work in North Carolina during the past year, which has been due to the employment of a forester. This has been made possible by the State Survey co-operating with the State Board of Education, according to the following agreement:

AGREEMENT BETWEEN THE STATE BOARD OF EDUCATION AND THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

In order to thoroughly investigate the forest lands belonging to the State Board of Education in regard to their timber and agricultural value; the perpetuation of such forest areas as is deemed advisable; the prevention of forest fires throughout the State; the reforestation of various areas in the State and other forest problems that may arise, the State Board of Education hereby agrees to appropriate for this work the sum of twelve hundred dollars ($1200.00), the same to be paid to the State Geologist for disbursement, in monthly installments of $100.00, beginning February 1, 1907.

The State Geological and Economic Survey also agrees to appropriate out of its fund a like amount for the forestry work.

Where it is necessary to make maps of the areas belonging to the State, the State Board of Education agrees to pay for such services out of other funds than those appropriated for this forestry work. It is also agreed by the State Board of Education that, when necessary, the services of Mr. Thompson and others now in the employ of the State Board of Education in connection with their swamp lands, shall be available.

The work shall be conducted and carried on under the direct supervision of the State Geologist.

The general plan of the work shall be:

To obtain as accurate a record as possible of the value of the lands belonging to the State so that on prepared maps of these areas the value per acre can be indicated as well as the character of the land.

The Forester appointed by the State Geologist shall have general supervision of the forest lands belonging to the State and shall, with the assistance of inspectors and others now employed by the State Board of Education, do all in their power to prevent timber stealing; shall make plans for cutting the timber when same is sold on stumpage; shall make plans for the prevention of forest fires; shall make plans and practical demonstrations of the cultivation of forests; shall draw up and carry out a plan for perpetuating certain forest areas according to definite and approved plans of the U. S. Bureau of Forestry; and shall investigate the diseases of trees and other problems that may be of benefit and value to forest lands.

By this arrangement, considerable work has been done during the past year in connection with the forestry problems that confront us. The first work taken up has been to determine the extent of the swamp lands of eastern North Carolina that are under the control of the State Board of Education and to determine their value. Plans have already been made for assisting owners of timber land in perpetuating their forests and making them more productive.

In connection with this work, seven different tracts have been examined in Bladen, Columbus, Camden, Onslow and Hyde counties. The county records of these counties, Bladen, Columbus and Cumberland, were examined and three tracts embracing about 300 acres of unsurveyed land of the State Board of Education were located in this way. Surveys have

been begun on land in Columbus and Bladen, while the survey of Holly Shelter swamp has been nearly finished. More than 300 letters were written in connection with the examination of these lands.

Four tracts of land have been examined and advice given the owners in regard to the methods of managing the timber. There are applications on file for the examination of three other tracts, aggregating nearly 40,000 acres; and for plans for planting cut-over pine land by a lumber company in Columbus County. These applications are the result of the offer of the Survey to assist owners of timber lands in the management of their properties. Considerable correspondence has been had with power companies in regard to planting waste lands on their properties which are subject to erosion and plans for planting will probably be submitted to some of these during the winter.

Another line of work that has also been undertaken is the reclaiming of barren and abandoned farm lands by planting them in trees. When it is considered that the forest area of North Carolina amounts to more than 10,000,000 acres, a very large portion of which is steep, rough or poor land which is not suitable for agricultural purposes and which, for many reasons, it is very essential should be kept in forests, it can readily be seen that the forestry work is very important to the State. This importance of the forests of North Carolina is strikingly shown by the fact that the forests and the industries dependent upon them produce material amounting in value to more than $35,000,000 a year, and give employment to 30,000 men. There are but few States in this country where the importance of the forests is relatively as great as in this State, where one-sixth of the entire wealth-producing capital is invested in forest lands or in industries directly dependent upon the products obtained from the forest.

The State of North Carolina recognizes that the furniture industry in the State is absolutely dependent upon a permanent supply of hardwood; that the tanning industry, if it is to become a permanent industry as it should, is dependent upon a constant supply of tanning material; and that the paper industry, which should also be a permanent one, is dependent upon a constant supply of pulpwood. The forestry department of the Geological and Economic Survey of the State believes that it is not only possible to make these industries permanent in the State and give them a constant supply of the woods that they need, but also to enable them to develop to a still greater extent.

Not only is it necessary that the present timber land not suited, when cleared, for agricultural purposes be kept as a perpetual forest, but also that the waste, or abandoned farm lands in the State should be re-

forested. There are approximately 2,000,000 acres of this waste land in the State which have either been lumbered and burned, or cleared for agricultural purposes and found unprofitable to cultivate on account of its roughness and the erosion to which it is subjected. This land represents idle capital of not less than $2,000,000. Instead of lying idle and producing nothing, it should be planted in trees, and thus become an area that will be constantly increasing in value.

In order that the Geological Survey may more effectively carry on its work in forestry, the following legislation is urged:

LEGISLATION RELATING TO THE PROTECTION AND PERPETUATION OF THE FORESTS OF THE STATE.

The General Assembly of North Carolina do enact:

CHAPTER —.

SECTION 1. That for the purpose of protecting the State's interests in its own land in eastern North Carolina under the control of the State Board of Education; for the re-forestation of waste and deserted lands throughout the whole State; and in order to be able to take up all problems relating to forestry in the State, the State Geological and Economic Survey shall employ a Forester and such assistants as may be necessary to carry out the provisions of this act.

SEC. 2. It shall be the duty of the Forester to acquaint himself with the extent and value of the lands owned by the State and under the control of the State Board of Education, and to make such recommendations regarding their care and sale, or sale of timber, as in his judgment will yield the greatest returns to the State. He shall also, under the direction of the Survey, make investigations relating to the re-forestation of abandoned farm lands throughout the State and demonstrate the practicability of such re-forestation. He shall, so far as possible, give advice and assistance to any county, city, or town regarding the planting and protection of decorative and shade trees within their borders; shall investigate ways and means for the prevention of forest fires which at the present time are destroying, each year, timber to the value of many thousand dollars; and shall investigate regarding the protection of the hardwood forests in western North Carolina. He shall make regular reports to the Survey of the work accomplished.

SEC. 3. The sum of $5,000 annually, is hereby appropriated out of any moneys in the treasury, not otherwise appropriated, for the purpose of carrying out the provisions of this act, to be drawn upon as directed by the Geological Board.

SEC. 4. That this act shall be in force and effect from and after its ratification.

Forest Fires.

One of the greatest evils that the State has to contend with in relation to forests is forest fires and, although there are certain fire laws in force in the State, they are not effective enough to prevent great losses each year by forest fires.

EFFECT OF FIRES ON THE FORESTS.

Eastern Counties.—One of the worst effects of the forest fires in eastern North Carolina has been the prevention of the long-leaf pine from reproducing itself. Large areas that were once covered with this valuable tree and which should now be reproducing another growth of the same kind are instead covered with sand oak or black-jack, which are practically valueless.

The loss to the people of this section from the burnings of these pine lands, taken in the aggregate, is enormous, as, but for the burnings, thousands of acres which are now denuded of all merchantable trees would either be covered with mature forests or with thick groves of young trees.

They have in many instances also destroyed the "bays" or swamps in which the white cedar or "juniper" grows, burning not merely all seed-bearing and young trees but the very soil as well, as it is usually peaty and contains a large proportion of woody matter. The hardwood timber in swamps has been less damaged, as the swamps only become dry enough to burn in the summer and fall, while the leaves are still green. Occasional fires, however, in exceptionally dry seasons do great damage.

Central Counties.—In the counties in the middle part of the State fires have done considerable damage in killing down young growth, but, as a general thing, except where there are large tracts of forest and the country is poor, rugged or thinly settled, the lands are not regularly burned and the damage that has been done to old trees is much less than in other parts of the State. These occasional fires, however, kill much young growth that has been several years growing and in this way keep the woods open.

Western Counties.—In the mountains, although there is a great deal of excellent hardwood timber, many of the trees which would otherwise be merchantable have been badly damaged by fire. The woods have been kept free from young growth by pasturage and frequent burnings. In places they are exceedingly open and there are no young trees at all to take the place of the old ones as they are removed.

About one-half of the forests in the mountains can be considered as consisting of original growth; the rest is either second growth, or has

been severely culled and consists of young trees, often largely coppice, that is, stump or roots, mixed with defective old trees. Once deterioration is fully under way, it proceeds rapidly. In many places fencing is obtained with difficulty, and the same is true of building materials.

Yellow poplars are decreasing, maples probably taking their place more largely than other trees. The white oak is not decreasing and in chestnut woods it is probably increasing. Scarlet oak is increasing, as is the chestnut oak in many places, though most of the young trees are stump shoots. Cherry, red oak and ash are decreasing. Locust is increasing, particularly around farms. Yellow birch, maples, beech and buckeye are increasing on northern slopes.

DAMAGE TO TREES BY FIRES.

Fires certainly do more damage to the pine and hardwood forests of the middle and western counties of this State than any other one, or possibly, than all other agencies. Except in the dampest woods of the higher mountains, there is scarcely a piece of woodland to be found which does not show traces of damage caused by them. The damage to standing timber is considerable, but it is doubtful if, on the whole, it is nearly so large as that to the young growth, which ought to be growing, or ought to have grown, to take the place of the old trees as they are cut or die.

CAUSE OF HOLLOWS IN TREES.

The greater number of hollows in immature and undersized chestnuts, yellow poplars and oaks, and in many other trees as well in the middle and western counties were caused, either directly or indirectly through fires, and it is likewise probable that the hollows far up the trunks of many of the larger trees are due to this cause.

Particularly in the early spring when the sap is rising and the trees beginning to grow, fires are apt to scorch small spots at or near the base of trees, which will kill the cambium or growing layer beneath the bark. The bark over the scorched place either falls off or becomes loosened. If it falls off the tree presents on its surface a layer of dead sapwood or of the growing tissue. This layer is rich in food materials, having been active and filled with sap when killed and is at once attacked by insects which channel the wood in all directions, or deposit their eggs and their grubs which hatch out and make openings in securing food. If the bark does not fall off, it will take longer for the insects to make their way beneath the wood. Through their openings thus made, air and water will enter, bearing the germs of rot and disease, or the insects may bring them in upon their bodies, and so, without the bark falling at all, the entire

base of the tree may become decayed, or even hollow within and show no signs of it from without.

When the bark falls after a tree has been scorched by fire, open hollows will be formed and subsequent fires will often aid in extending them up the trunk of the tree.

FINAL RESULTS OF FOREST FIRES.

The burning of the woods, begun in some places a great many years ago and constantly repeated, has seriously interfered with the natural growth of the trees. Many of the tender kinds have become less abundant, as is the case with the long-leaf pine, while hardier kinds, which from their thick bark or the ease with which they sprout form the stump, roots, or at the base of the tree, have managed to survive and even increase as their competition with other trees was lessened. In the mountains both the chestnut and the chestnut oak have maintained themselves where trees that sprout less vigorously from the stump have perished. Their persistence, however, has been due to their ability to sprout from the stumps or roots and not from new seedling plants. In the middle part of the State the black-jack oak is in many places following black oaks and pines; in other places sourwood from seedlings and suckers is increasing at the expense of more valuable trees.

Besides influencing the kinds of trees, only those which are hardiest maintaining themselves, fires affect to a large extent the natural development of form in the individual trees. The growth is kept open, the crowns of the trees not interlacing as they should to insure proper development; height growth ceases at the expense of rapid enlargement of the trunk; and great crowns or tops are formed. Short-bodied timber, with many knots in the upper part of the stem, is the result, lessening, of course, the strength and timber value of the piece. The stems of hardwood trees are often crooked from the same cause, and where two or more shoots come up from the roots of a small tree, the top of which has been killed, not infrequently both of them will fail to make trees of value. Even where the hardy trees succeed in securing a foothold, it is sometimes only after having been killed down several times that they reach maturity several or many years later than they should and delaying the final yield of the product by so many years. The total amount of woody material grown in thin woods is much less than if the growth was kept thick and reduces the amount of salable timber from the forests by just so much.

Continual burning injures the soil by leaving the humus, leaves, etc destroyed and the ash washed off by rains.

To sum up: When the woods are burned, the final yield is less; the timber reaches maturity after a greater number of years; there are more defective trees; the timber is not of so good a quality; hardy kinds are propagated at the expense of tenderer kinds which often have a greater timber value.

In order to more effectively prevent forest fires and thus protect our timber supply, I would earnestly urge that the following legislation relating to the protection of forests from fires be enacted.

LEGISLATION TO PROTECT THE FORESTS OF NORTH CAROLINA FROM FIRE.

CHAPTER —.

The General Assembly of North Carolina do enact:

SECTION 1. That Section 3324 of the Revised Statutes be changed to read as follows: If any person shall set fire to any grass land, brush land or any woods except it be his own property, or, in that case without first giving notice in writing to all persons owning or in charge of lands adjoining to the woodland or other land intended to be fired, at least two days before the time of firing such lands, and also taking care to watch such fire while burning and taking effectual care to extinguishing such fire before it shall reach any lands near to or adjoining the land so fired, he shall, for every such offence be guilty of a misdemeanor and be punishable by a fine of fifty dollars, one-half to go to the person who brings the suit and one-half to go to the State Treasurer to be used for forest protection. This shall not prevent action for damages sustained by the owner of any property.

SEC. 2. That Section 3325 of the Revised Statutes be changed to read as follows: Any wagoner, hunter, camper or other person who shall leave a camp fire without fully extinguishing it, or who shall permit any accidental fire from any torch, gun, match, or other origin to burn in any grass or woodland without fully extinguishing it, shall be guilty of a misdemeanor and shall be punishable by a fine of fifty dollars, one-half to go to the person who brings the suit and one-half to the State Treasurer to be used for forest protection.

SEC. 3. Every person or company operating a locomotive or logging engine in this State shall equip the same with a spark arrester of a character and condition approved by the Corporation Commission and any person or company who operates one not so equipped shall be subject to a fine of one hundred dollars for each such offence, one-half to go to the person who brings the suit and one-half to the State Treasurer to be used for forest fire protection.

SEC. 4. Forest Wardens or any agent of the State may recover from owners or operators of locomotive by a suit in court the cost of extinguishing or controlling any fire which originates from their locomotive, and any money so collected is to be repaid to the county and State pro rata accordingly as they contributed to the expense of extinguishing the fire. Such recovery shall not prevent action for damages by owners of property which has been injured.

SEC. 5. Four or more owners of timber lands in any one township, or the owners of one-third of the forest land in the township, can petition to the State Forester for the appointment of a Forest Warden for that township and, after such application, a Forest Warden may be appointed by the Governor to serve at his discretion and such Deputy Wardens as may be deemed necessary can be appointed by the State Forester to act with the warden in any such township.

SEC. 6. Wardens shall have charge of measures for controlling forest fires; they shall make arrests for violations of the forest laws; shall post copies of the forest fire laws and warnings against fires which shall be supplied by the State Forester; and they shall perform such other duties as shall be considered necessary by the State Forester for the protection of forests.

SEC. 7. All able-bodied male persons between 18 and 40 years of age can be summoned by Forest Warden or Deputy Warden to assist in extinguishing forest fires, but no person can be compelled to serve more than two days in any year. Persons shall be paid for their services in extinguishing fires at the rate of ten cents per hour, and the total amount which may be expended in any one township shall be limited to fifty dollars in one year. Any person summoned by a warden or his deputy and not attending, without sufficient excuse to the warden, shall be subject to a fine of five dollars in a suit brought by a warden or deputy before any magistrate.

SEC. 8. No landowner can be compensated for services rendered under this act in extinguishing any forest fire on his own land; nor can any employee of any person or corporation receive compensation for such services in controlling fires on the lands of his employers.

SEC. 9. Forest Wardens and their deputies shall have the same powers as deputy sheriffs so far as the provisions of this act are concerned. Neither Forest Wardens nor their deputies shall be liable for trespass while acting in the performance of their duties, nor shall any person be held guilty of a trespass for going on land when summoned by an officer to control a fire.

SEC. 10. Forest Wardens and their deputies shall be paid at the rate

of fifteen cents an hour for the time actually engaged in the performance of their duties, according to an itemized statement rendered the Forester every month and approved by him, out of any moneys in the State Treasury not otherwise appropriated. Persons summoned by wardens shall be paid upon vouchers signed by wardens and approved by the State Forester, three-fourths of the amount being paid by the State Treasurer out of any moneys not otherwise appropriated and one-fourth being paid by the County Treasurer out of the county funds of the county in which the fire originated.

Appalachian Forest Reserve.

The question of an Appalachian Forest Reserve has been given considerable attention and consideration by the State Geologist, and he has gone to Washington several times as a member of committees to appear before the Speaker of the House of Representatives regarding the passage of the bill relating to the establishment of the Appalachian Forest Reserve.

In investigating the necessity of establishing this Forest Reserve, the President's Conservation Commission, consisting of Hon. Charles F. Scott, of Kansas, Chairman of the Committee on Agriculture, Senator Reed Smoot, of Utah, Professor H. S. Graves, Director of the Yale Forest School, and Mr. William Irvine of Wisconsin, together with W. L. Hall of the U. S. Forestry Department and Joseph Hyde Pratt, State Geologist, made a trip through portions of the mountain sections of North Carolina and Tennessee. Stops were made at Toecane, Mitchell County; Johnson City, Tenn.; Asheville, Buncombe County; Waynesville, Haywood County; and Balsam, Jackson County. On this trip it was possible to show the Commission the final results that can be expected if the forest areas of the mountain sections of western North Carolina are cleared. Some areas were noted where all the soil had been eroded, leaving the hillsides barren and unproductive and illustrating very completely why the streams rising in the vicinity of these badly eroded hillsides were subject to heavier freshets and longer periods of low water than formerly.

Sand Banks and Dunes.

During 1907, an examination was made of the sand banks along the North Carolina coast to determine in a general way the damage that was being done by drifting sands on the area examined and also to enable the Forester to recommend methods of protection against further damage. The results of this examination, which was made by Mr. J F. Bond, Forestry Assistant of the U. S. Forest Service, are given below:

REPORT ON AN EXAMINATION OF THE SAND BANKS ALONG THE NORTH CAROLINA COAST.

By JAY F. BOND, Forest Assistant, U. S. Forest Service.

INTRODUCTION.

The following report is the result of a brief examination of the banks off the North Carolina coast between Cape Hatteras and the wooded area about six miles west of Beaufort Inlet. This investigation was undertaken by the Forest Service at the request of the State Geologist of North Carolina and was intended only to determine, in a general way, the damage being done by drifting sands on the area examined. If considered necessary, methods of protection against further damage were to be recommended.

The portion of the banks covered by this report is typical of the entire strip and within this area are the only places where active protective measures seem to be required at the present time. A detailed plan for the treatment of these lands is included in this report.

DAMAGE BY SHIFTING SANDS.

There is abundant evidence, throughout the area examined, of marked changes within a comparatively recent time. Within the recollection of many of the present residents, practically the entire banks were forest covered. At present, however, the forests occur only at two points. Immediately west of Cape Hatteras are approximately 2500 acres covered principally with loblolly pine. Recent estimates of the amount of pine in this stand approximate 20,000,000 feet board measure. Although this figure seems excessive, there is undoubtedly a considerable amount of valuable timber in the forest. The trees are of medium size and the lumber of relatively low value, but the accessibility of the stand and the great market for even the poorer grades will make the exploitation of this timber profitable. These lands are held by private owners and the stumpage is controlled by a company which holds an option at $.50 per thousand feet, B. M. This option expires January 1, 1910.

Poor business management has caused a suspension of logging operations, but it is practically certain that lumbering will be resumed in the near future and that a considerable portion of the forest will be removed before the expiration of the option, since it could be renewed only at a much higher rate.

Near the western end of Shackleford Banks are a few hundred acres of forest composed almost entirely of red juniper. This is being exploited in a small way for posts.

The entire area between these points is barren and unproductive. Only at the villages of Hatteras and Ocracoke where the residents maintain small gardens is there any attempt to utilize the land in any way except for the pasturage of a small number of stock. Sand more or less fixed in the form of dome-shaped dunes extends from the ocean to the sounds. The damage here is complete and the improvement of the area as a whole is practically impossible.

There are two localities on the area under discussion where protective measures would prove a decided benefit. At the southeastern and southern part of the woodland near Cape Hatteras the blowing sand is rapidly encroaching upon and destroying the forest while at Beaufort Inlet the surface

sand is being blown into Core Sound and, through the destruction of the beach, the width of the inlet is perceptibly increasing. The problem of arresting the damage at these two points is discussed in detail below.

CAPE HATTERAS FOREST.

Along the entire southern and western edges of the forest west of Cape Hatteras a considerable area of woodland is being buried and destroyed by blowing sand. As stated above, this timber has a distinct value and, in addition to its value for lumber, the occurrence of the forest makes this locality by far the most desirable residence section of the banks. It is simply a question of a rather limited time, however, when the encroachment of shifting sands, together with destructive logging, will complete the permanent denudation of the area.

The greatest difficulty to be encountered in the treatment of these lands is the fact that they are private property and therefore can scarcely be controlled by legislative action. Apparently nothing can be done, except in an advisory way, to regulate the exploitation of these woods. Fortunately, however, the logging operations were begun at the sound side of the forest and farthest remote from the area being encroached upon by the sand and hence the cut-over area will have an opportunity to reforest naturally before the removal of the timber immediately in the lea of the approaching sand dunes. The large proportion of loblolly pine in the stand makes reproduction certain with a minimum of protection. It is certain, however, that by far the greatest factor in the destruction of the original stand has been careless lumbering.

The destruction resulting from logging has been made permanent by unrestricted grazing. Cattle, sheep, goats and hogs have free range and the damage from these sources cannot be over-estimated. Hogs are the greatest menace and a single hog, practically valueless, will root out large areas of sand-binding grasses along the beach. Cattle and sheep complete the destruction by eating the roots of the uprooted grass. The sand thus liberated is carried away by the wind and a "blow-out" results. This "blow-out" constantly enlarges until the damage becomes general and large areas are affected.

Even if grazing were an important industry on the islands, free range of stock would be fatal to the industry itself as well as to the general productiveness of the lands. The reverse is the fact, however, since competent observers place the total value of all stock between Cape Hatteras and Hatteras Inlet at no more than $1000. The cattle, sheep and horses are in-bred and of minimum value while the hogs are practically worthless, since the meat is unfit for consumption, owing to the carrion fish upon which they feed.

It is strongly recommended, therefore, that the State Legislature enact suitable laws providing for the fencing of all stock upon this portion of the banks. This will work no real hardship upon stock owners and, moreover, is an economic necessity if the industry be made profitable. Without such legal protection, all measures for the control of shifting sand such as are described below will be useless. In addition, natural reproduction on the cut-over forest areas cannot be satisfactory since, under present conditions, live oak reproduction, which would otherwise be abundant, is missing and even pine reproduction is very seriously damaged.

The sand-dune area which is encroaching upon the forest lies to the south and east of the woodland. Beginning at a point two miles east of Creed's Hill Life Saving Station, it extends westward four and one-half miles and beyond the wooded area where the sand extends entirely across the banks to the sound. A description of this area and certain recommendations appear below.

CAPE HATTERAS SAND-DUNE AREA.

The moving sand of the dune area between the forest and the ocean has already covered up and destroyed the growth for about one-half mile inland. At the western end of the dune the sand gradually slopes into a low marshy area which extends to Durant's Life Saving Station where a small body of live oak occurs. To the south of this woodland is a long, narrow sand dune and to the west a low wash-flat extends to Hatteras Inlet where there are a few mound-like dunes near the beach.

It is only the dunes immediately south and west of the Cape Hatteras forest which are discussed below, since the dunes further to the west can do practically no damage. Over this entire area the sand is constantly moving in a northeast direction. The surface is practically bare of vegetation and such growth as does spring up from time to time is promptly destroyed by stock.

The direction of the movement of the dunes is undoubtedly influenced by the forest growth which shelters the area from the northerly winds. From the south the winds have uninterrupted sweep and, in consequence, the sand is carried by these winds in a northerly direction. The prevailing winds in the different seasons also have a greater or less influence on the direction in which the sand is carried. During the summer the sand becomes very dry and in this condition is easily carried by the winds which are southerly at this season. In the winter, however, the moist condition of the sand prevents it from being easily carried by the northern winds which prevail. The result is that even where the winds have full sweep in both directions the general movement of the dunes is toward the north.

At the northern end of the sands the dunes terminate abruptly at the edge of the woods. Here there is a high dune rising gradually to a height of about 25 feet. To the leeward the slope of the dune is fully 35°, which seems to be as steep as sand will remain at rest.

The rate at which this dune is advancing inland could not be determined in the short time available. It is very evident, however, that the advance is relatively rapid, since there are numerous living tops of trees protruding above the sand considerably to the windward of the crest of the leeward dune.

To control and fix these sands will require most careful treatment and an expense entirely disproportionate to the value of the reclaimed land and of the forest lands in the lee. So long as the present conditions in respect to laws and the ownership of the greater part of the area exist, protective measures are impossible. In addition to the enactment of stock laws as recommended above, it is recommended that the State acquire by purchase a strip of the forest land in the lee of the dunes not less than 500 and preferably 1000 feet wide and extending along the entire area so far as the forest occurs. When this has been done the active measures looking to the control of the sands may be put into effect.

THE FIXATION OF THE SANDS.

The permanent reclamation of the sand waste depends upon two things: (1) Since the source of supply of the sand is inexhaustible, a barrier must be provided near the beach to prevent new supplies of sand which are brought up by the surf from being blown inland. (2) The loose moving sand in the lee of this proposed barrier must be permanently fixed by growing forests.

The success of all work relative to the satisfactory growth of the trees and consequent binding of the sand depends upon the barrier and past experience has established that this barrier is most satisfactory, if it consists of a littoral dune of proper height built up by sand which is arrested by means of mechanical obstructions and held in place by suitable sand-binding grasses. It should be built up parallel to the shore line and not nearer than 100 feet to high-water mark.

When the work of fixation is complete, the entire area, with the exception of the strip between the barrier dune and the shore line, will be covered by a forest. The strip to the windward of the barrier must be held in place by the planting of grass. When the forest has been established, it should be cared for according to usual forest practice.

It will be impossible to establish a forest directly upon the drifting sand either by sowing the seed or by setting out young trees, since the blowing sand either uncovers the seed or buries it too deeply, while in the case of planted trees, the sand cuts the leaves and bark or buries the plants. It will therefore be necessary to hold the sand in place by some mechanical covering until the trees have developed and formed a natural cover.

The work of fixation is thus divided into two stages: (1) Preliminary, holding the sand in place. (2) Permanent, establishing a forest. Upon the coast strip the work never proceeds beyond the first stage and the maintenance of a grass cover will require constant care.

THE COAST STRIP AND BARRIER DUNE.

The coast strip and the barrier dune should be handled in such a way that the surface of the strip may not jeopardize the stability of the dune. It is obvious that the first work is the proper formation of the dune. This is done by rapidly accumulating blowing sand so as to form a long ridge. For this purpose, palisade fences arranged in a double row 6 feet apart are used. Each fence should be made of inch boards 6 inches wide and 5 feet long, driven about 2 feet into the sand. The tops of the fences should be of equal height and the palings should be four inches apart. Such an arrangement of fences allows the wind to pass through, but reduces its velocity and hence sand is deposited within and on both sides.

As the sand accumulates to the tops of the fences, the palings should be raised and, when the dune has reached a height of 30 feet, sea oats (*Uniola paniculata*) should be planted 3 feet apart, alterating in rows 3 feet apart, parallel to the crest of the dune. The grass should be planted on both sides of the dune and gradually extended toward the windward until the dune attains a fairly permanent form with a gradual slope to the windward, while on the leeward side the slope will be approximately 30°. The successive steps in the formation of the barrier dune is shown in the series of diagrams accompanying the report. (See Plate II.)

The barrier dune, when completed, will protect the area in the lee but will require constant care to keep it in proper condition. Every precaution should be taken to prevent a break in the dune and, if such occurs, it must be repaired immediately, since the wind will constantly enlarge the opening. A break may be repaired by the simple expedient of piling brush on the surface of the "blow-out" and, when the sand has filled in to its former level, by replanting grass as before. The main care should be to maintain a good grass cover over the dune and the coast strip. When the grass becomes thin in one place, plants should be taken from areas where it is thicker than necessary and replanted where required.

FORESTATION.

The area in the lee of the littoral dune must be planted in forest trees to accomplish permanent fixation. Local conditions and geographical position of the area to be planted are such that proven methods developed in extensive work of this character in Europe may be adapted to this project.

It has been established that the most certain method of securing a forest cover on waste sands is by direct sowing of the seed, provided that suitable species are available for use in the locality and also that the sand be temporarily fixed until the young trees are well established. Upon the formation of the barrier dune the sands in the lee will be comparatively free from the action of the wind, since the dune will protect the area from the southerly winds, while the forest will serve as a windbreak to the north.

Loblolly pine, a rapid growing species which produces valuable timber, grows throughout the banks. Although, owing to the exposed situation, the quality of timber produced cannot equal that of the forests of the mainland, this tree is by far the most desirable commercial species on the banks.

The proper method of sowing the seed can be determined only by experiment. Two methods are suggested, the second to be used only when it has been clearly demonstrated that the first is not feasible. (1) Sowing the seed directly on the surface. (2) Sowing the seed after the sand has been temporarily fixed by a light covering of brush.

At the western end of the shore dune, on a strip 500 feet wide and extending from the dune to the forest, loblolly pine should be sown at the rate of 12 pounds per acre. The seed should be sown directly on the surface of the sand without any preparation of the site. Although there is good reason to count upon favorable results, there are several possible objections to this method. Large quantities of the seed are almost certain to be destroyed by birds and to guard against this the seed should be coated with red lead before being sown. Again, wind will blow away some of the seed and in other cases will cover the seed too deeply with sand. It is certain that the action of the wind will be greatly reduced by the littoral dune and the forest, but just how efficient this shelter will be can be determined only by actual experiment.

It is obvious that if the sweep of the wind over the area in the lee of the dune is not reduced to a minimum, the success of planting by direct sowing without previous preparation of the site will be impossible. In such a case the surface of the area to be planted must be covered with a light covering of brush, laid in rows parallel to the barrier dune. Seed should then be sown at the same rate as above among the brush.

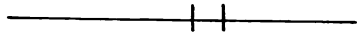


Fig 1

Fig. 3

Fig. 2

Fig. 4

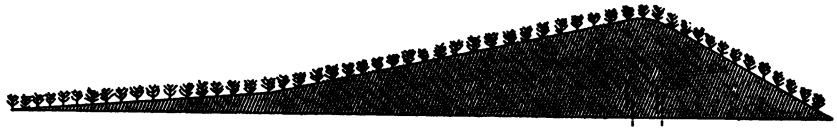


Fig. 5

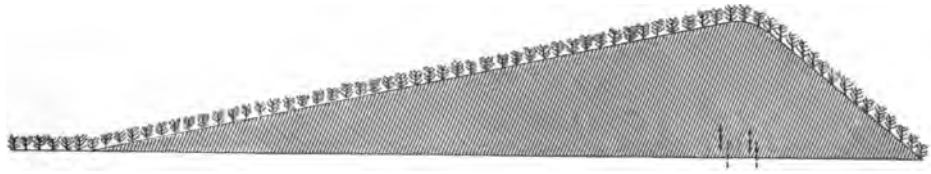


Fig. 6.

DIAGRAMS EXPLAINING PROGRESSIVE STEPS IN THE FORMATION OF BARRIER DUNE

When the dune has assumed the form illustrated by Fig. 4, grass is planted, and by extending the area planted towards the shore (to the left) the subsequent form of the dune is influenced.

M40U

Such a method, although more expensive than the first plan, will insure success. The brush should be allowed to remain until the young trees are established and the year following the sowing it should be removed in order not to interfere with the growth of the seedlings.

Brush can be obtained from the nearby forest. Myrtle, red bay, yaupon, or any similar material may be used. Brush cut from the tops and limbs of conifers after lumbering will serve admirably. Such material may be obtained from recently cut-over areas in the forest.

The forest immediately in the lee of the sands, the purchase of which has been recommended above, should be carefully conserved. Absolutely no cutting should be permitted until the dune forest is firmly established.

The expense of fixing the sands can be only approximated. There was no opportunity in the limited time available to determine the rapidity at which the barrier dune would accumulate. It is obvious therefore that the cost of the dune cannot be determined, since it will vary directly with the length of time which will elapse before it assumes permanent form. The cost of forestation can, however, be approximated, and will vary from $25 to $40 per acre, depending upon the method. Seed of the loblolly pine are quoted in the market at $2 per pound but could undoubtedly be secured by contract at a much lower figure. Material for the palisade needed in the building up of the barrier dune represents a first cost of $900 at present prices and labor for its construction will add at least $500. The cost of maintenance cannot be predicted.

Grass planting on the coast strip and the littoral dune will be expensive and at least $500 must be allowed for this work exclusive of maintenance.

The entire cost of the work of fixation, exclusive of any expense necessary in the acquisition of the lands, will reach at least $40,000.

ADVISABILITY OF PROJECT.

This report does not aim to outline a policy. It merely suggests a definite plan by which the areas under discussion can be protected and leaves the advisability of the action to the proper authorities.

The work of fixing the sands will serve to accomplish the perpetuity of the only forest remaining on the banks above Beaufort Inlet. If prompt measures, such as outlined above, are not taken, the destruction of the forest is certain. The lands will become a sand waste similar to the larger part of the area of the banks. The cost of the work, however, is large and it is doubted if the value of the property to be protected will equal this cost.

Aside from the intrinsic value of the property, it must be considered that this area supports a considerable population which will be seriously affected should the land become waste. These people are entitled to protection by the State and, although relief could be secured by temporary measures involving less immediate expense, the method of treatment recommended necessitates the lowest cost consistent with permanent protection.

If, however, the project is undertaken, it is strongly advised that the work of carrying out the details of the general plan advised be entrusted to a competent official and be made a part of his duties.

THE BEAUFORT INLET PROJECT.

The Department of War maintains a series of sand fences on either side of Beaufort Inlet at the entrance to the harbor. These fences are to hold the sand as it is brought to the beach, in order to build up the beach and prevent the inlet from increasing in width. The effect of the blowing sand which might be deposited in the channel is not considered, since the currents will serve to keep the channel clear.

Since the Department of War has made provision for the continuance of this protective work, a further discussion is not essential.

However, if the State takes up the work outlined in this report, it is suggested that the proper official keep in close touch with the work at Beaufort Inlet.

Forestry Publications.

A number of publications have been made relating to forestry during the past two years. One was on Shade Trees for North Carolina, which was published as Bulletin No. 16. In the publication of this report it is the desire of the Geological Survey to arouse within the State a more thorough appreciation of the necessity and beauty of shade trees on the streets of our cities and towns. To this end, descriptions are given of the majority of the shade trees suitable for street and park planting in different sections of the State and illustrations have been used to show more effectively the advantages to be derived by a town or city through the judicious planting of suitable trees on their streets. Many towns now realize that shaded parks and streets bordered with neatly kept rows of trees are an asset of very great value. In many instances where a town is without such shade trees it has begun to plant them and the present bulletin will be of considerable assistance to such towns in the selection of the proper trees for planting, the suitable time of year to set them out, and how to care for them and protect them from disease and insects. Various combinations of trees that grow well together and harmonize with each other are given and also suggestions regarding combinations of trees to give pleasing effects of color in the spring when the trees are flowering and in the fall when the foliage is turning. To the person who is interested in tree planting for his own yard, the bulletin should be of some considerable value inasmuch as it goes into detail in regard to the transplanting and pruning of trees.

A short chapter is devoted to Arbor Day and it is hoped that the bulletin will be the means of promoting a more general observance of this day in the State, especially in the public schools, which will thus inculcate in our school children a love for our trees, and as they grow up, they will appreciate not only their beauty but also their real value to the place in which they may happen to live. One of the customs of Arbor Day is

the planting of trees and, if but a few trees are planted each year by each school throughout the State, it will mean that a great many portions of the State will in a few years show most strikingly the advantage of systematic planting.

Another bulletin that is in manuscript form and ready for the press is on The Loblolly Pine in Eastern North Carolina. This bulletin will give a large amount of data and information relating to the rate of growth of the loblolly and other pine trees, together with suggestions regarding re-planting of lands in pine trees.

The Forester has also prepared a series of Press Bulletins relating to Forestry that have been published from time to time and are widely distributed throughout the State. In this work of disseminating information regarding our forest lands and their value, we have had the hearty co-operation of the press of the State who have very generously published the various articles in whole or in part that have been sent out as Press Bulletins. This publicity cannot but help to interest the people of North Carolina in the preservation of our forests so that the industries dependent upon them will be permanent and not temporary enterprises in our State.

Twenty-one lectures were also made by the Forester in as many different counties in the State.

Terracing of Farm Lands.

One result of the clearing of forest areas is that erosion is more rapid and, if the land is not protected, erosion will extend rapidly on the slopes of our hills until in some instances all the soil will be entirely washed away, leaving the slopes indented with deep gullies. A study has been made of such conditions in the Piedmont section by the Forester and the results of this investigation have been published as Bulletin 17, on Terracing of Farm Lands. This subject is one that should be more seriously considered by the farmers of North Carolina, especially in this Piedmont section. This is one of the methods that can be satisfactorily employed in conserving this soil. For certain sloping farm lands no better or cheaper means can be devised. Where attempts have been made to utilize terracing methods and these have not resulted as favorably as expected, it has usually been that sufficient care and attention were not given to the location and construction of the terrace. They have been either too far apart or had too much grade on their upper sides. These points are carefully discussed in the report and it is hoped that this report will be the means of creating a more general use of terracing in the Piedmont section.

MAGNETIC SURVEY.

Since the establishment of the magnetic survey in North Carolina, which was begun in 1898, the stations are being re-occupied in order to determine the changes in the declination. During the past two years two stations were re-occupied and one new station established. The new station is at Goldsboro and takes the place of the old station at that point which was found unsuitable for future magnetic work. The new one is in the southern part of the City Park, about one mile southeast of the center of the town and about 255 feet a little east of south of the Park shelter house. It is 50.3 feet from the edge of the east brick border of the road to the west which runs south from the main gate and 134.7 feet from the fence on the south border of the Park. The station is marked by limestone posts 6 x 6 x 30 inches, projecting four inches above the ground and lettered U. S. C. & G. S., 1908. The following true bearings were determined: From north corner of tower of Wayne cotton mill ....42° 53′ W. of N. From north cupola of Dawson home.....50° 4.5′ W. of S.

The following are the magnetic observations that were made in 1907-08. There is also given the early observations at the same points.

MAGNETIC OBSERVATIONS AT NORTH CAROLINA STATIONS.

Station.	County.	Date.	Declination.
Roan High Bluff.	Mitchell.	May 17, 1907.	1° 26.9′ E.
Goldsboro (old station).	Wayne.	March 2, 1908.	2° 18.6′ W.
Goldsboro (new station).	Wayne.	March 4, 1908.	2° 13.3′ W.

EARLY OBSERVATIONS AT NORTH CAROLINA STATIONS.

Station.	County.	Date.	Declination.
Roan High Bluff.	Mitchell.	September, 1894.	0° 33.4′ E.
Goldsboro (old station).	Wayne.	May 25, 1899.	1° 50.3′ W.

A complete list of declinations of North Carolina observations at county seats are given in the reports of the U. S. Coast and Geodetic Survey for 1898-1899 in a separate, known as Appendix No. 9.

FISHING INDUSTRIES.

At the session of the legislature of 1907 an act was passed creating the Fish Commission of North Carolina whose work was to be under the supervision of the Geological Board. This has meant that the State Geologist has had to give considerable time and attention to the work of this Commission and he has also audited all its accounts.

Unfortunately, however, for the obtaining of the best results from the work of the Fish Commission, the jurisdiction of the Commissioner is

restricted, as the following counties were exempted from the bill: Beaufort, Camden, Carteret, Craven, Currituck, Hyde, Jones, New Brunswick, New Hanover, Onslow, Pamlico and Pender. One unfortunate result to the State from having these counties exempted from the jurisdiction of the Fish Commission is that the U. S. Bureau of Fisheries cannot consider co-operation with those counties exempted from the bill, the position the Bureau takes being that if a county is not willing to do all it can to have the laws relating to fish and fisheries enforced, that the U. S. Bureau of Fisheries cannot afford to spend its time and money in trying to build up an industry while the people are tearing it down. The Geological Survey and the Fish Commission have received the most cordial co-operation from the Bureau of Fisheries in connection with their work. By means of this co-operation it was possible to make a careful survey of Chowan River, Albemarle, Croatan and the eastern portion of Pamlico sounds and thus have marked out the restricted areas relating to fishing. This survey was made by Mr. W. F. Hill and, while it was preliminary, it accomplished the results desired. It is necessary, however, that a permanent survey should be made and the restricted areas marked with buoys. In order to do this work, Mr. John H. Small, Congressman of the First District of North Carolina, introduced a bill into Congress asking for $15,000 to carry out this work. This bill will be taken up at the short session of Congress.

It was considered advisable to hold another Fish and Oyster Convention and the Governor, as Chairman of the Geological Board, called this meeting to be held on August 26 and 27, 1908, at Morehead City. At this convention the present fish and oyster laws were carefully considered and new legislation recommended which the committee believed necessary for the preservation of the fish and oyster industries of the State. The deliberations of this convention have been published as Economic Paper No. 16, and I would call especial attention to the suggestions of this convention regarding general legislation relating to the cultivation of the oyster and clam; to the protection of the terrapin; and to an early closing season for shad and herring.

Oyster Cultivation.

The results of the investigations that have been carried on relating to the cultivation of the oyster by Messrs. R. E. Coker and H. D. Aller, have been published as Bulletin No. 15, on Experiments in Oyster Culture in Pamlico Sound, North Carolina. Experimental oyster beds had been made and kept under constant observation for three to six years, notes having been taken regarding the density of the water, number of diatoms

it contained, growth of the oyster, etc. These experimental plants have for the most part been very successful during the time in which they have been made and to some extent cultivated, and they indicate that there are large areas in Pamlico Sound that are suitable for the cultivation of the oyster and that this can be done profitably. The report describes in the greatest detail the methods employed in making the plantings in order that the results obtained may be profitably used by those who wish to take up the cultivation of the oyster. It is hoped and expected that the results of this investigation will be the means of awakening new interest in oyster culture in North Carolina and that large areas of the bottom of Pamlico Sound will be entered for this purpose. It is necessary, however, that some such legislation as has been recommended by the convention relating to the cultivation of the oyster shall be passed by the legislature, if this cultivation is to be taken up.

Clam Cultivation.

An investigation has been begun by Mr. Howard E. Enders, of Perdue University, in connection with the work of the Beaufort Laboratory, on the cultivation and propagation of the common clam, *Venus mercenaria*. In describing the work accomplished, Mr. Enders reports as follows:

The problem was approached in four ways: (1) By an attempt to raise young clams from the eggs; (2) by systematic towings; (3) by means of a device for catching "spat" and causing it to settle where the bottom seems favorable to the growth of clams; (4) noting the distribution and habitat of young clams in the harbor.

It was possible to fertilize the eggs in considerable numbers throughout July and August by stimulating them by means of various chemicals before the sperm was added. In spite of the large number of eggs that were thus fertilized, a comparatively small number passed beyond the four- and eight-celled stages, and still fewer reached the veliger stage. This is in large part due to the presence of a few fully-developed, or ripe eggs, together with many unripe eggs in the gonad. This number of ripe eggs increases rapidly when the animals are kept in captivity in well aerated water, but at no time were any eggs extruded by the animals in captivity in the laboratory tanks.

The towings during July yielded variable numbers of young free-swimming lamellibranch mollusca with well-developed shells ¼ millimeter long. They were provided with two adductor muscles for closing the shells. These shells are of the same shape as in older clams. The foot was small so long as the young clams were free-swimming, but as the animals change their habit to burying, the foot and siphon became conspicuously developed.

The tendency of the free-swimming young clams from the towings to retract the velum and settle to the bottom of the vessel as a result of an irritation led me to believe that a device such as the Japanese use in oyster culture would yield results as a "spat catcher." Accordingly, a square enclosure of

planks (9 x 9 feet) was constructed at the edge of a shoal near the laboratory. A portion of one side was open so that water might enter freely with the change of tide, and its height was such that the high tide swept over it. Branches were set in the bottom of the hollow square so that their tops extended beyond the top of the enclosure. No clams were found within this enclosure at the time it was constructed but four weeks of exposure to the tides during August yielded a dozen young clams (*Venus mercenaria*) which ranged in size from 2.1 to 5.0 millimeters in length. The sandy bottom of the enclosure had become covered with a thin layer of diatomaceous mud much like that found over many of the clam beds of the vicinity.

Young clams were found quite generally distributed throughout the inner portion of the harbor. (The young clams were collected by means of a fine sieve whose meshes were 1.5 millimeters square.) They are most abundant where the currents are not strong; coarse sandy shores did not yield any young animals. Clams which varied in size from 1.7 to 11.0 millimeters in length were found early in July. This diversity in size continued through August when they were collected in sizes from 2.0 millimeters upward to 18.0 millimeters in length, the average being about 5 millimeters. Collections were made from the same areas at intervals of several weeks to determine the rate of growth of the young animals in the first season.

The breeding season of *Venus mercenaria* extends through several months when a small number of eggs is discharged at short intervals under natural conditions; therefore the attempt to rear the young from the eggs in large numbers is not feasible.

Fishes of North Carolina.

A report that has been very favorably received and I believe has been of great value to the fishing interests of the State is on the Fishes of North Carolina, prepared for the Survey by Dr. Hugh M. Smith, Deputy U. S. Commissioner of Fisheries. The report has been prepared to meet the numerous inquiries that are constantly being received by the Geological and Economic Survey concerning the fishes found in the different waters of the State. It has been the desire of the State Geologist to awaken an increased interest in the local fishes, and to give to the people of North Carolina and to others a more accurate knowledge of the abundance, distribution, habits, migrations, spawning, food value, etc., of the fishes, in the belief that such knowledge will lead to a fuller realization of the economic importance of the fishery resources of the State. It is desirable also that there be created a deeper interest in the welfare of both fishes and fishermen, and a better understanding of the condition and needs of the fishing industry, with a view to placing this important branch on a permanent basis and making it yield an increasing revenue to both State and people.

In this report there is an account of every fish that has been ascertained to inhabit the fresh, brackish, or salt waters of North Carolina. All

local names by which the fishes are known are recorded, and diagnostic descriptions are given that are often based on local specimens. Colored plates or text cuts representing a very large number of the species have been provided. While the chief aim in preparing the report has been to make it of practical usefulness to the fishing interests, the scientific aspects of the subject have not been neglected and the work will be found to have a value to ichthyologists and to zoölogists in general.

The report is particularly useful in that it affords a means of identifying any fish that may be taken in State waters. The artificial keys are based on external characters that commercial fishermen and anglers may readily appreciate; and the copious index of common names gives a further clue to all the species whose size makes them objects of capture.

It is hoped that this volume will be the means of creating such an interest in the fisheries that suitable laws for their protection may be enacted as needed, and that the State officers charged with the administration of the fisheries may have the sympathy and co-operation of all citizens.

JAMESTOWN EXPOSITION.

At the request of the North Carolina Commission to the Jamestown Exposition, the State Geologist was authorized by the Geological Board to take charge of the North Carolina mineral exhibit and to arrange for same. This work was undertaken early in January, 1907, and various mineral producers in the State were called upon for exhibits of their mineral products. In arranging for the mineral display, particular attention was given to those minerals which offer attractive investments for capital. Special emphasis was made of building stones and clay products and, through the co-operation of the North Carolina Granite Corporation, the Balfour Quarry Company, the Rowan Granite Company and the Consolidated Granite Company, it was possible to outline the space of the North Carolina exhibit with a balustrade of cut granite with two arches at the entrance, as is illustrated in the frontispiece of this report, which also gives a general idea of the installation of the exhibit. The building stones were further represented by columns and spheres of polished granite that surmounted the corners of the balustrade. The clay products were well represented by samples of crude kaolin and of pottery manufactured from it; and of terra cotta, tiling and sewer pipes, and bricks manufactured from other forms of clay.

The excellent collection of gems furnished by the American Gem and Pearl Co., of New York, the State Museum and by Joseph Hyde Pratt, represented fully the gems and gem minerals occurring in the State.

The mica, talc and monazite industries, were also comprehensively represented by crude, intermediate and finished products, arranged so as to illustrate the various steps of the manufacture of the materials into the finished products. These were furnished by the Sylva Mica Company, the North Carolina Talc and Mining Company, the American Lava Company, the Talcum Puff Company, the Glendon Mining and Manufacturing Company, the Croatan Company, the Carolinas Monazite Company, the Welsbach Light Company, the German-American Monazite Company, the Nernst Lamp Company, and the Highland Forest Company.

Other mineral resources exhibited were gold, copper and iron ores, corundum, chromite and tin minerals, coal, graphite and mineral waters.

The State Geologist was assisted in the installation and care of these exhibits during the period of the Exposition by Miss H. M. Berry, Messrs. R. T. Allen, Elden Bayley, Duncan MacRae and Joseph E. Pogue, Jr., and to them the State Geologist is indebted for their efficient work and their courtesy in explaining to visitors the character of the exhibits and seeing that the mineral samples and pamphlets for distribution were advantageously distributed.

It is the belief of the State Geologist that the mineral exhibit at the Jamestown Exposition, notwithstanding the comparatively small attendance, did attract the attention of capitalists to the mineral resources of the State and also brought many buyers to the producers of the mineral products. The actual benefit that the State derives from such an exhibit cannot be estimated in dollars and cents and very often results of the exhibit are realized years after the Exposition.

PUBLICATIONS.

During 1907 and 1908 the following publications have been issued by the North Carolina Geological and Economic Survey, which embody the results of the investigations briefly outlined above and to which references have been made:

VOLUMES.

II. The Fishes of North Carolina, by Hugh M. Smith, 453 pages, 21 pl., 188 figs.

BULLETINS.

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 60 pp., 15 pl.

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 74 pp., 17 pl., 11 figs.

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 74 pp., 10 pl., 16 figs.

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 38 pp., 6 pl., 2 figs.

ECONOMIC PAPERS.

14. Mining Industry in North Carolina during 1906, by Joseph Hyde Pratt. 144 pp., 20 pl., 5 figs.

15. Mining Industry in North Carolina during 1907, by Joseph Hyde Pratt.

16. Report of Convention Called by Governor R. B. Glenn to Investigate the Fishing Industries of North Carolina, compiled by Joseph Hyde Pratt, 1908. 47 pp., 1 map.

17. Report of Drainage Convention Called by the Geological and Economic Survey, compiled by Joseph Hyde Pratt, 1908.

Good Roads Circulars and Press Bulletins.

During the past two years 20 Good Roads Circulars and Press Bulletins have been issued and distributed throughout the State. These have taken up all sorts of questions pertinent to the subjects of good roads, forestry, waterpowers, drainage, fisheries, mining, etc. The object of these Press Bulletins is to bring constantly before the people of the State what work the Survey is doing so that, if they are interested in any particular line of work, they will know when it is being taken up and can obtain at an early date the information desired regarding it.

The following reports are now ready for the press and should be ready for distribution early in 1909.

BULLETINS.

18. The Loblolly Pine in Eastern North Carolina, by W. W. Ashe.

20. The Waterpowers of North Carolina, by M. R. Hall, E. W. Myers and Joseph Hyde Pratt.

21. The Resources of the Coastal Plain Region of North Carolina, by L. W. Stephenson, E. W. Berry, B. L. Miller and Joseph Hyde Pratt in collaboration with W. B. Clark.

The following reports are in preparation:

VOLUMES.

III. Mineral Resources of North Carolina, by Joseph Hyde Pratt.

IV. Birds of North Carolina, by T. Gilbert Pearson and C. H. Brimley.

V. Mica and the Pegmatites of North Carolina, by Joseph Hyde Pratt and D. B. Sterrett.

VI. The Cretaceous and Tertiary Formations of North Carolina, by E. W. Berry and B. L. Miller.

BULLETINS.

Gold Hill Copper Deposits, by F. B. Laney.

A List of Elevations in North Carolina, by Joseph Hyde Pratt.

A Bibliograpny of North Carolina Geography, Geology, Mineralogy, Petrography and Paleontology, by Joseph Hyde Pratt, F. B. Laney and L. C. Glenn.

ECONOMIC PAPERS.

Mining Industry in North Carolina during 1908, by Joseph Hyde Pratt.

OFFICE WORK.

The office work of the Survey has been carried on by the State Geologist assisted by Mr. F. B. Laney, Assistant Geologist; Miss H. M. Berry, Secretary and Stenographer, with Mr. R. T. Allen, S. V. Bowen and Miss Nellie Barbee as temporary assistants. The correspondence of the Survey office requires a considerable part of the time of the State Geologist and his secretary and about 6,000 letters have been written at this office, besides circular letters, during the past two years. These letters relate to the value of mineral properties, methods for developing and mining of same, markets for mineral products, information regarding waterpowers, artesian wells and mineral waters, forests, available tracts of forest lands, different varieties of timber, etc.; the construction of public roads and localities for obtaining material for road construction; value of the oyster and fish industries and laws relating to same, etc. The Survey Office has tried to provide itself with all information possible relating to the natural resources of the State so that it will be in a position to answer any and all inquiries received relating in any way to our natural resources. For this reason, letters received at other Departments of State relating to natural resources are usually referred to this office for reply.

There is a constant demand for the various publications of the Survey, which are being sent into all parts of North Carolina, and requests are being received from all over the United States for them. The information that they contain has been the means of calling attention to various investment propositions in the State with the result that considerable capital has been brought into the State for developing them.

Each publication means considerable work for the State Geologist and the office force in editing the report and reading the proof of same as it is passing through the press.

In order to keep in touch with all publications relating to the geography and geology of North Carolina, a bibliography is being prepared relating to the geography, geology, mineralogy, petrology and paleontology of North Carolina. The State Geologist is being assisted in this work by F. B. Laney, Miss H. M. Berry and Miss Katherine Wood.

The following statement will show the receipts and expenditures of the North Carolina Geological and Economic Survey for the two years ending November 30, 1908, grouped according to the subjects investigated during this time. These are arranged separately for each of the two years. The receipts cover moneys received from the State Treasurer, representing the annual appropriation, and the sums received from counties and others for co-operative work of various kinds as indicated.